Anita Thaler, Christine Wächter (eds.)

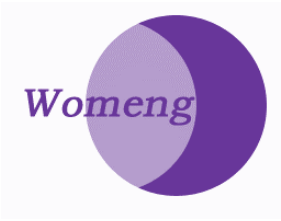
International Conference

Creating Cultures of Success for Women Engineers

6-8 October 2005
Schloss Retzhof, Leibnitz/Graz, Austria

Conference Proceedings

WomEng is a research project (HPSE-CT-2002-00109) funded by the EC under FP5.



Project coordinator: Dr. Yvonne Pourrat

www.womeng.net

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http://www.ifz.tugraz.at/

Published by:

IFF/IFZ, Graz, Austria

Layout: Dr. Anita Thaler

ISBN 3-9500472-4-7

CONTENTS

Single Sex Education in Engineering – An Attractive Chance for Women

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Abstract

Although engineering studies are equally open for men and women in highly industrialized western countries like Germany, the number of women participating in engineering programs and practising a related profession is extremely low and only slowly increasing. In the last decade many programs and initiatives have been implemented in order to change this situation. The results were disappointing.

Then single sex programs were invented with innovative curricular structures in association with international interschips and contacts.

One outcome is that in a society with a strong rhetorical emphasis on gender equality, single sex education is seen as old-fashioned and is therefore criticised and questioned.

But this modern version of single sex education is a strategy and reform concept in order to fundamentally change technological culture as such. In a single sex educational context, so the hypothesis, gender stereotypes are not performed, differences between women become more obvious, their self-esteem and self-confidence can develop and they are supported to leave the traditional spheres, cross borders and climb to the top. International networks of women in high engineering positions can influence the decisions of younger women to study engineering and enter related professions. This question is to be discussed.

Outline

- The historical victory of co-education in Europe, particularly Germany
- Gender theory based justification for a reflective mono-education in Germany
- Experiments with temporary gender-segregation in technical and science subjects at German universities
- Conclusion

The historical victory of co-education in Europe

In Europe there is a consensus in educational policy that male and female pupils and students, regardless of their gender, should be educated in the same way.

Whether boys and girls can actually attend the same educational establishments, with the same long-term success, is, however, dependent upon how far an understanding of an equality of gender has been established and which gender stereotypes dominate.

Considering a lay understanding of early education, in Germany, an interest in technology and natural sciences is subscribed to a great extent to the male gender. Nevertheless there are many efforts to work against this in educational policy.

The introduction of co-education in Europe

Until far into the 1900's the education of male and female youth in higher education was performed in separate institutions. It was only in the first half of the 20th century that co-education slowly established itself. Socialist countries have a special position here as co-educational upbringing is part of their social and cultural philosophy. This had the effect in eastern European countries of a larger proportion of women studying engineering.

Today a co-education of the young generation is the norm. Since the 1980's in Germany only a small number of state schools and a few private institutions exclusively for girls or for boys have remained, mostly Catholic grammar schools. In the German Democratic Republic (DDR) co-education has been the norm since 1945 in all types of educational institutions.

In the Federal Republic of Germany the implementation of co-education was begun in the 1960's and 1970's with the understanding that

- this was a "natural" upbringing for the young generation
- gender roles were being redefined
- girls and boys had the chance to learn from each other

It was the girls' schools which resisted opening up for the other gender longer than the boys' schools[1]. The stronger resistance of the girls' schools was also based on the policy about jobs. The management of girls' grammar schools had offered an area within the labour market for ambitious female teachers. With the merging of schools into the co-educational model, on the one side there was a glaring reduction in the number of women in leading positions in schools[2] whilst on the other side the status of former girls' schools was improved with better equipment and changes in the curricula as well as equal access to higher education for girls and boys. The discussion of a common or separate education for girls and boys is also a part of the discussion revolving around the allocation of societal resources between the genders.

On the other hand, the university system has been completely co-educational since 1909. The critical debate on co-education in Germany was instigated by research results which showed that a much larger proportion of female students studying engineering and natural sciences had attended all-girls' schools (in the 80's this was even more obvious than now) than would have been anticipated in relation to the proportion of girls' schools which existed in the school system (Kauermann-Walter/Kreienbaum/Metz-Göckel 1988). These findings led to the hypothesis that an interest in natural science and engineering subjects could be better awoken in girls attending modern girls' school than in a co-educational

[1] This was also the same for Women's colleges in the USA (Metz-Göckel 2004)

[2] Girls' schools were predominantly run by women as well as having a higher percentage of women on the teaching staff.

environment. Additionally more and more research findings showed that female and male pupils were not interested in common lessons (shown in the choice of advanced courses in maths/physics and languages in the upper grades of secondary schools) (Metz-Göckel 1987). Furthermore critical women's studies research reported continuous unequal treatment of male and female pupils in co-educational classrooms (Ender-Dragässer/Fuchs 1990).

Some educational state laws in Germany now contain a clause which allows schools to temporarily segregate classes in certain subjects within the co-educational school system. Since then there have been a few educational experiments where courses for girls in physics, chemistry and particularly information technology have been introduced. A positive effect for the girls is generally reported (Häussler/Hoffmann 1995, Kron-Traudt 1989, Hannover 2000). Additionally empirical studies from psychological social cognition research can verify (Kessles 2002) that female pupils in homogenous groups in, for example, physics, develop a sounder interest in the subject and can better incorporate this into their gender identity than female pupils in co-educational courses. Under particular circumstances a segregated training of women can create effects which work against gender stereotypes (Metz-Göckel 2000)[3].

Nevertheless, these "experiments" with separating the genders are seen as discriminatory (such as extra help or safe space). Such devaluation is mostly expressed by the boys, but also by girls. Both genders prefer co-educational education.

Gender theoretical basis for a reflective mono-education in Germany

The theoretical controversy in regard to co-education and mono-education relates to the context and the effects of mono-educational lessons. We are dealing here with two contradictory assumptions.

The first one, based on Erving Goffman's theory (1994) says that the separation of the sexes accentuates the sense of belonging to one's own gender and strengthens therefore the differences between genders in that they are institutionally supported. In all-girls schools and boys-only schools "mythical images" of the other gender are created which necessarily fall back on stereotypes because the other gender is missing, whereas the co-educational situation creates a school context in which a realistic examination is practiced (Faulstick-Wieland 2000). Co-education can in this sense be understood as a cultural prevention of the polarisation of gender.

The second position, based on Judith Lorber's theory (1999), says that the constant presence of both genders supports, on a subtle level, the polarisation of stereotypes. The social norms, which are influential in the school and universities force boys and girls to differentiate from each other. The concentration on one gender in a mono-educational setting opens more possibilities to recognise and emphasise the differences between the individual girls or boys. A purely female or male context, according to this hypothesis, pushes differences between women, or men, to the foreground and represses the individual's common identity to one's own gender. Generally, the extent to which differences between girls and between boys develop undermines the foundation of the polarisation of the genders. This however only occurs in such areas where gender is highly polarised, e.g. in engineering science in Germany and also

[3] In this regard, information about women's colleges in the USA, particularly the famous women's colleges on the east coast, have created a lot of attention.

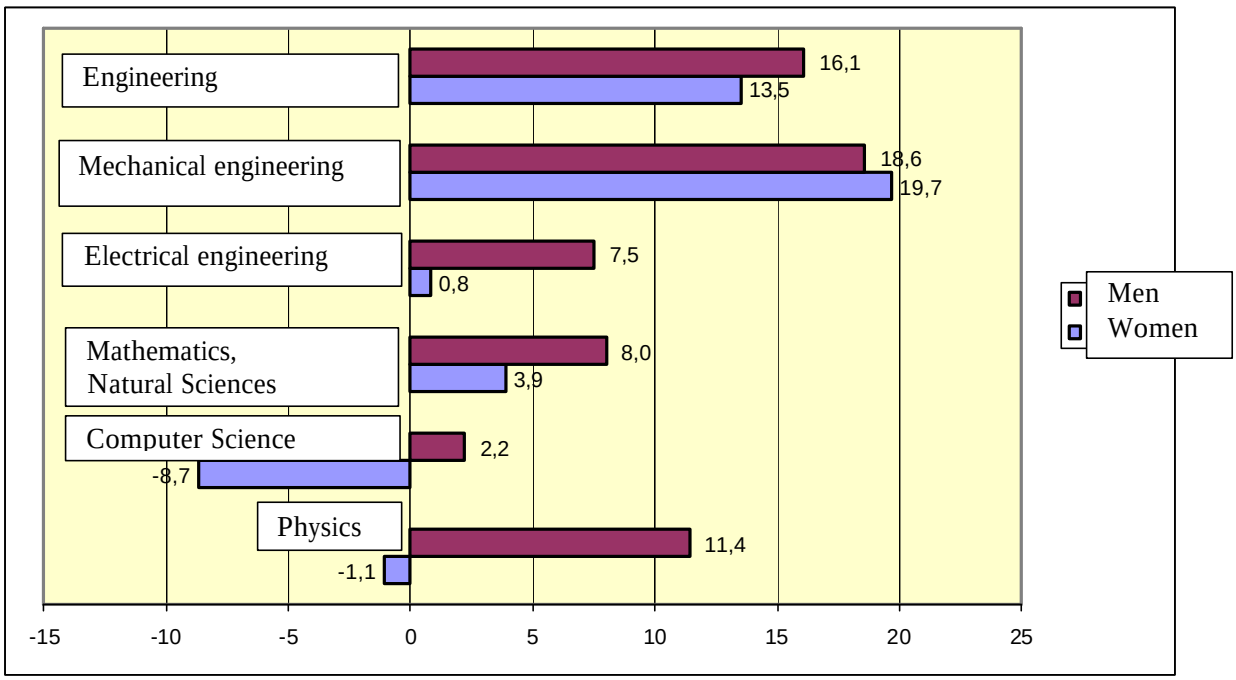
information technology. Partial mono-education in a co-educational context is a paradoxical intervention in that it outwardly dramatises the polarisation of gender so that within it can be destroyed.

The acknowledgement of this paradoxical effect is the starting point for initiatives within the German university system to create courses of study exclusively for women. Another university reform experiment is the international women's university (Metz.Göckel 2002).

Single sex education as a reform concept: Experiments with temporary gender segregation in the German university system

After a phase in which the number of students beginning university studies in engineering and natural sciences (with the exception of information technology) dramatically declined, there has been a slight increase since the Millenium in the number of students studying these subjects, although again the number of women in IT and physics has declined and there is a smaller proportion, overall, of women in these subjects. Mechanical and process engineering is the only subject (since the introduction of new areas such as logistics) which has shown women as composing the greater proportional increase of those studying the subject, the proportion being 20%.

Tab. 1: Development in First Years admissions in Engineering, Mathematics and Natural Sciences in relation to 2002 in 2003 per %



Source: Women in Engineering and Natural Sciences at German universities 2003 "At a Glance"

In Germany a very particular type of women's study has recently developed. In the last few years a number of courses of study in engineering have been offered additionally for women or exclusively for women. The reasons for this new segregation of the genders are:

- the dramatic decline in the number of pupils choosing to study natural sciences and engineering and

- the theoretical assumption that a course of study exclusively offered for women in a traditionally male dominated subject would motivate more women to study this subject, as well as improving their self confidence and motivation to complete their studies.

These courses of study are seen as "crisis-generated experiments" which challenge the normal routine where segregation of the genders in a co-educational environment can have provocative effects. Because of its "unexpected side effects" it can also be dangerous in that it can strengthen prejudice and can fail to influence women unless it is carried out under particular conditions.

Women-only courses of study as a corrective to co-education

We are dealing here with courses of study in which women are extremely under-represented, e.g. IT. These are linked to various reforms, e.g. in terms of the curriculum, in order to make them more interesting than the mere fact that they are single-sex courses[4]. One Technical college (Fachhochschule) has, despite increasing student numbers, implemented a parallel course of study in Business Engineering for women only. The introduction of this course was preceded by an educational reform which augmented the number of courses dealing with internationalisation, the teaching of interdisciplinary team competence and self-access teaching and learning forms. These reforms aimed at generally changing the organisation and content of courses of study in engineering science disciplines in order to make these courses more attractive to women (but also to men). These courses were not exclusively about easing women's fears of starting something new, or making up for a deficit of information, but rather to introduce curricular and higher educational reforms in order to modernise courses of study and e.g. focus more on the teaching of core competences.

These experiments aim at more than the simple segregation of gender, namely:

- they are a new way of attracting women students
- they represent a reformation of the content of courses of study
- they incorporate a rethinking of teaching practice in creating an open climate for questions, discussion and communication which facilitates the acquisition of key competences
- they reflect changes in the job specification and qualifications profile of male and female engineers. Leadership qualities, team spirit, conflict management and intelligent problem solving are now understood as being part of interdisciplinary key competences.

Up to now the experience of a deliberate or specifically strategic gender segregation has shown that the so called "women specific" offers are not accepted by young women when they are seen as "private coaching" and without changing the curriculum and offering concrete employment perspectives. A temporary mono-education can therefore only work as a corrective reform when a free choice is given (the possibility to change from a mono-educational to a co-educational course of study at any time) and they do not prescribe a specific definition of femininity (Teubner2000).

The International Women's University as a higher educational experiment and international network

[4] Such reform-based projects exist for example at the Technical Universities of Wilhelmshaven and Stralsund as well as the University of Bremen („International women's course in information technology"). Such courses have established a co-operative of women-only courses of study.

The International Women's University "Technology and Culture" which took place during the World Expo in 2000 in Germany was a global project with a limited post-graduate study offer for about 700 women from 105 countries. It was conceived as a higher educational reform project with the aim of offering female up-and-coming academics a worldwide forum for education and discussion. The offer was interdisciplinary, addressing key international political problems within five project areas of which two were engineering sciences (Water and Information). It is perhaps of interest to this panel that the fact that this offer was exclusively for women was only welcomed by a third of participants at the time of applying. Nevertheless, the final evaluation found that the exclusiveness was met with broad support once participants had made the experience. The great satisfaction of the participants was caused by the inter-relationship between the female experts and the fact that the curriculum was gender sensitive (Metz-Göckel 2002).

Conclusion

In a predominately co-educational context mono-education, specifically women's space, is different from mono-education in an educational system with an alternative parallel structure in men's and women's universities or co-educational and mono-educational institutions, such as in the USA. In countries with strong gender segregation, mono-education may be the only access women have to (higher) education and being within a homo-social women's context may conform completely to their cultural context. In Europe, however, women as well as men see it rather as a step back into the distant past. In technical and natural science disciplines where women are extremely under-represented, mono-education can be a reform vehicle for modernisation.

In some countries with a tradition of highly respected women's universities, e.g. South Korea, there are also developments where some of these universities become co-educational whilst others successfully take over the function of educating women for leading positions in the country. Nevertheless, one must acknowledge that the younger generation, as a rule, dearly prefers co-education. Therefore that is why mono-education must prove that it is superior. It is, therefore, important to know what educational background women in leading positions in the engineering studies and profession have and what position they take on the question of co-education and mono-education.

The question is how can international networks of top women Engineers support and influence women choosing engineering as a study subject and working in that profession.

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Towards Gender Equality in Academia: Problems, Policies and Practices

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Abstract

Gender (in)equalities in higher education, academia and scientific research have become an issue of growing policy concern in Europe since the late 1990s. Statistics and research have shown that gender equality has not been achieved in higher education quantitatively or qualitatively. This is so despite the fact that women have made great gains in higher education during the last decades. At the beginning of the 21st Century, women account for more than half of graduates in higher education in Europe. At the doctoral level the average national proportion of women in the EU-15 was 39.6% in 2000, although their numbers are increasing faster than men's. Among faculty, and especially the professoriate, heavy male dominance continues and the gender balance appears to change very slowly: in only three EU-25 countries: Finland, Latvia and Portugal, the proportion of women of full professors is over 20%, and in several EU countries less than one out of ten professors are women.

Technology and Engineering is the most male-dominated academic field in Europe. Compared to other disciplinary fields, it produces the lowest proportion of women Ph.D.s (EU-15 average for 2001 was 20.6%) and employs the lowest proportion of female researchers in the higher education sector. Technology and Engineering also employ the lowest proportions of women full professors in Europe, ranging from 1% in Belgium and 1.7% in Austria to 6.8% in Poland. (She Figures 2003).

The paper discusses policies and practices aiming to make change happen and to promote gender equality in higher education at European, regional and national levels. Promoting gender equality in academia and scientific research is currently strongly on the agenda of various stakeholders nationally and internationally: universities, research councils, other funding bodies, and policy makers. Despite such efforts, change towards greater gender equality has been slow. In European science policy, mainstreaming gender equality in academic and scientific organisations is currently seen not only as an important goal which would enhance individual women's opportunities to use their potential. It is also seen more generally as a way to promote excellence. Promoting gender equality is increasingly seen as quality assurance ("equality equals quality").

Comparative Look at Gender and Higher Education in Europe

Europe can be considered as an interesting 'laboratory' to explore and understand problems and prospects related to gender equality and conditions of women in higher education. In Europe, a large variation can be found in the intensity of tertiary education, the size and character of the gender gap in tertiary education, the historical development of women's education, overall gender relations in society, including gender ideologies, women's labour force participation and provisions to facilitate work-life balance, and poli-

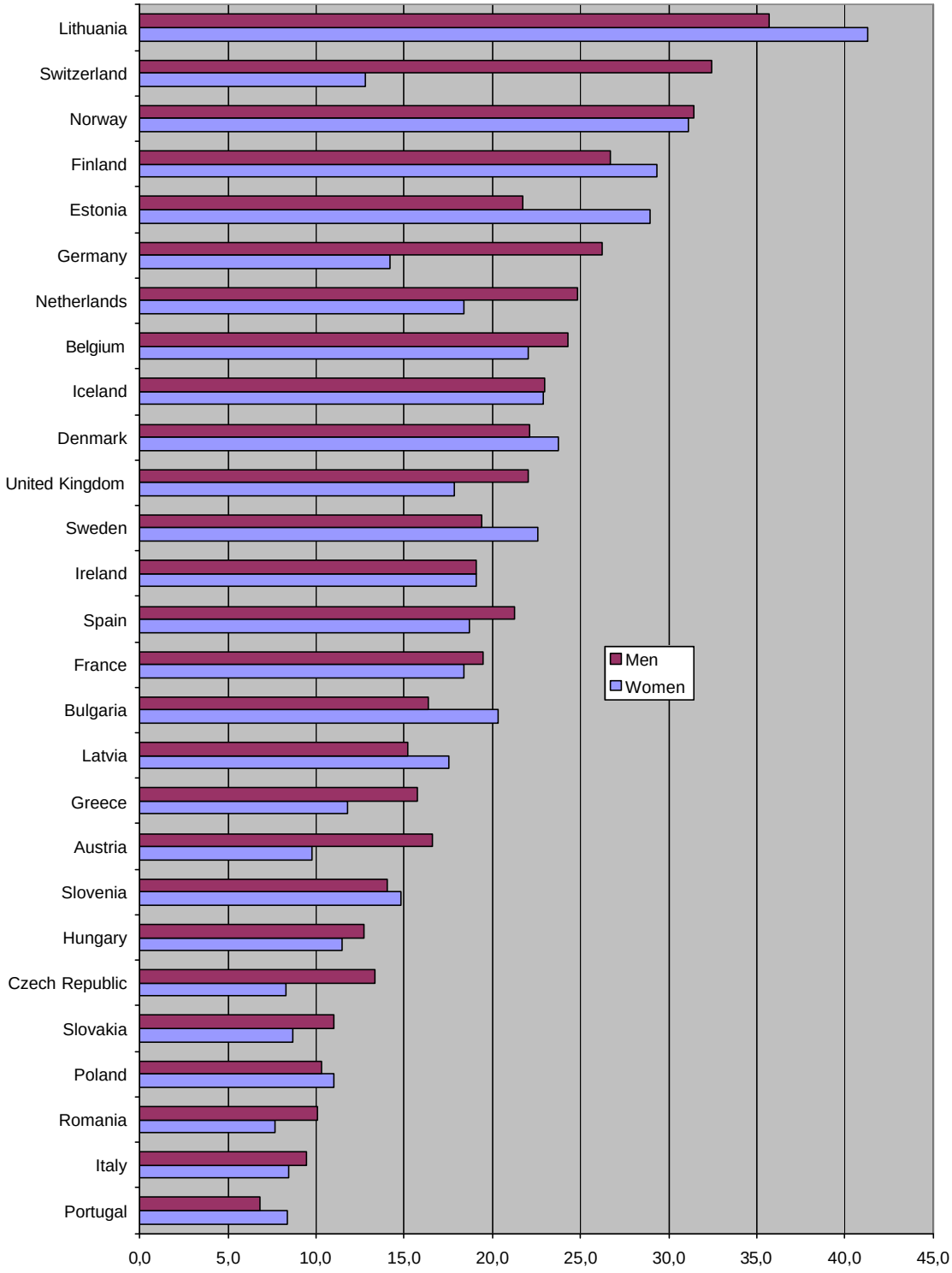
cies promoting gender equality both generally in society and in higher education and R&D specifically.

Gender gap in Europe in educational attainment

Great variation can be observed in Europe in the educational attainment of the population in general, both when it comes to the *proportion of the population with tertiary education* and *share of women among them* (see Figure 1, data from UNECE 2003). Lithuania, Switzerland and Norway are countries with highest proportions of population with tertiary education, whereas in Portugal, Italy, Romania and Poland tertiary level education has been reached by only one in ten. Interesting differences in gender profiles are found among those European countries with a high overall proportion of population with tertiary education. Countries with high proportions of tertiary educated population include countries with a *remarkable gender gap in men's favour*, especially Switzerland and Germany; countries with relatively *even gender distribution*, such as Norway; and countries with a clear *gender gap in women's favour*, such as Lithuania. Furthermore, among countries with relatively low proportion of population with tertiary education, such as Slovakia, Poland, Romania, Italy and Portugal, there are countries with gender gap either in men's or in women's favour.

Similar *variations in the gender gap* can be observed across Europe among countries regardless of the proportions of tertiary educated population. Countries with *nearly even gender distribution* in the population with tertiary education include, in addition to Norway, Iceland and Ireland. Countries with *gender gap in women's favour*, in addition to Lithuania, include the Nordic countries of Finland, Denmark, and Sweden, the Baltic countries of Latvia and Estonia, a few Central Eastern European countries, such as Bulgaria, Slovenia and Poland, as well as Portugal. In the tertiary educated population there are *higher proportions of men*, in addition to Switzerland, in the two other German-speaking countries of Germany and Austria, in UK, Netherlands and Belgium, in the Mediterranean countries of Spain, Greece, and Italy, and in the Central Eastern European countries of Hungary, Czech, Slovakia, and Romania. The gender gap does not thus follow obvious geographical lines, neither is it directly linked to the long-term intensity of tertiary education in the country. Some clusters can, however, be pointed out: the three Baltic and five Nordic countries come out as an area with very small gender gap or gender gap in women's favour, and the German-speaking countries as an area with a remarkable gender gap in men's favour.

Figure 1. Women and men with tertiary education 2001, % of population 25 years and over (source: UNECE 2003)



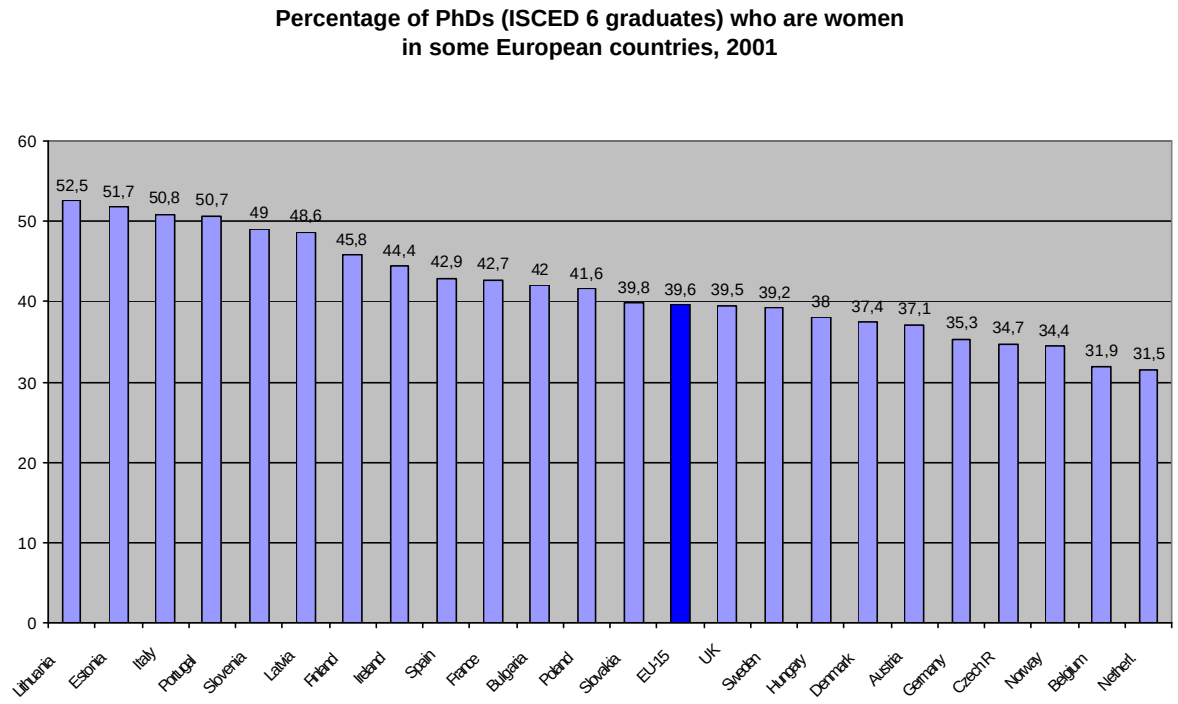
The gender gap described above concerns the working age population of the 25 years old and older. Among younger generations the situation is changing. Towards the end of the 1990s, in most European Union countries (EU-15) more women than men were educated to tertiary level. In 12 out of the EU-15

countries women represented the majority of university (and equivalent) students in 1998-1999, and even larger proportions of those graduating. The number of women in tertiary level education also increased faster than that of men throughout the EU (Dunne 2001). Of the population aged 20-29, participation rates were higher for women than men in 12 of the EU-15 member states (out of 12 from which data was available); only in Germany and Austria did men have somewhat higher participation rates in 1999/2000 (Starck 2003). What is noteworthy thinking of women's future career development in academia and research is that women tend to participate more in university programmes with a practical/technical/occupational orientation than men and less in theoretically based or research-preparatory programmes that would give access to professions with high skill requirements (Dunne 2001).

Doctoral level

Women outnumber men in most European countries in participation in tertiary education in general, but their proportions tend to decrease at the doctoral level, again with interesting variations between countries. In 2001, the proportion of women among Ph.D. graduates in the EU-15 was nearly 40% but clearly higher in wider Europe (new Member states and some associated countries) (see Figure 2).

Figure 2.



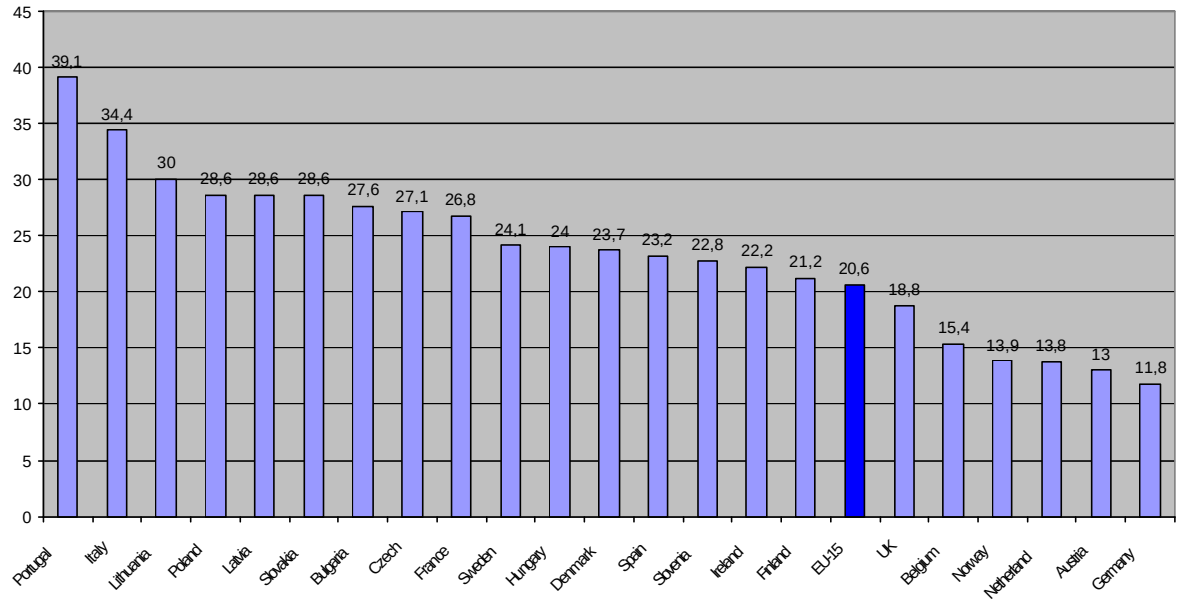
Source: She Figures 2003; exceptions for reference year: Denmark, France, Italy, Finland: 2000.

As could be expected, countries with high proportions of female Ph.D. graduates include countries with high tertiary education intensity among the female population, such as Lithuania, Estonia and Finland. But it is noteworthy that in Portugal and Italy, countries with among the lowest tertiary level education intensity in Europe, there is an even gender distribution among the Ph.D. level graduates. Countries with a lower than EU-15 average proportion of female Ph.D. graduates include, as one might expect, Austria and Germany, countries with a large gender gap in men's favour among the population with tertiary education. Interestingly, also the three Nordic countries of Sweden, Denmark and Norway where women's tertiary

level education intensity is equal or higher than men's, produce less female Ph.D. graduates than the EU-15 average and neighbouring Finland. Finland differs clearly from its Nordic neighbours with a relatively high proportion of female Ph.D. graduates, well over the EU-15 average.

Figure 3.

Percentage of Ph.D.s (ISCED 6 graduates) who are women in engineering, manufacturing and construction in some European countries in 2001



Source: She Figures 2003; exceptions for reference year: Denmark, France ,Italy, Finland:2000.

In Engineering and Technology, the country profiles are slightly different and the proportions of women generally lower than among Ph.D. graduates in general (Figure 3). In no country does the proportion of women exceed 40%, and the lowest proportions are found in Western Europe: in Austria, Germany, Netherlands, Belgium and Norway only a little more than one out of ten Ph.D.s in these fields is obtained by women. Mediterranean and Central Eastern European countries clearly produce proportionally more female Ph.D.s in technological fields than other European countries, and Nordic countries except Norway somewhat more than EU-15 average. The large gender gap among technological Ph.D.s is especially noteworthy in Norway, taking into account that in Norway tertiary education intensity has traditionally been high, and there is no gender gap in tertiary education in general

Gender in academic careers

How are women represented in academic research and teaching? Statistics on women's representation in academia and research have not been easily available from many European countries; in some countries they simply have not been gathered at all. Recently, the availability of statistics has remarkably improved thanks to the European Commission Women and Science activities.

In general, women are still underrepresented in European research and overall patterns of distributions are very similar between countries when comparing the gender balance in different sectors of research: higher

education, governmental, and business sector. Women are best presented in the Higher Education Sector: around a third of researchers in higher education were women in EU-15 countries in 2000, but under a third in Governmental Sector research, and only 15% in the Business Sector (She Figures 2003).

Diversity in career structures in European university systems complicates comparisons across countries. The position of full professor is generally the highest academic position in European countries, which makes it a useful indicator to comparative analysis. However, the proportion of full professors of the academic staff varies between countries, as does their relative status, and this has to be taken into account in comparative analysis. In higher education systems with a high proportion of full professors there are obviously more opportunities for women's advancement than in systems where positions of full professor are scarce. The position of full professor also carries important symbolic value; professors can be seen as role models for younger generations of researchers. The professoriate in Europe consists overwhelmingly of men even in such countries in which 35% or more of total academic staff is female, as indicated in Table 1.

Latvia, Portugal and Finland have the highest proportion of women full professors within the EU-25; two out of 10 professors were women in these countries in 2000. The top ten countries with the highest proportions of women among full professors (20.9% – 13.8%) include four Mediterranean, two Central Eastern European, and two Baltic, two Nordic but no Western European countries. It is striking that Norway and Sweden, Nordic countries with long-term and generously funded gender equality promotion in the universities, backed by the Government (see, for example, Bull 1999; Edgren 1999; Jordansson and Shands 1999; Soyland et al. 2000), have not succeeded in recruiting more women full professors compared to the Baltic, Central Eastern European and Mediterranean countries in which gender equality promotion activities have been remarkably more modest (see Rees 2002).

Table 1: Proportion of women of academic staff and of full professors (grade A) in Europe 2000, Head Count

	% OF WOMEN, ALL GRADES	% WOMEN IN GRADE A (FULL PROFESSOR)
LATVIA	55.4	20.9
PORTUGAL 1999*	39.6	19.3
FINLAND	39.1	19.0
BULGARIA	43.4	17.8
POLAND	32.8	17.7
ESTONIA	42.6	17.5
FRANCE	32.3	16.2
SPAIN 1999	32.2	15.1
ITALY 2001	29.8	14.6
SWEDEN 2001	28.3	13.8

NORWAY	35.7	13.3
UK	35.8	12.6
ICELAND	29.9	12.0
LITHUANIA	47.5	11.8
GREECE	25.6	11.3
SLOVENIA	25.4	11.1
DENMARK	28.0	8.3
CZECH REP.	34.0	8.1
SLOVAKIA	36.2	7.9
GERMANY 2001	27.0	7.7
BELGIUM 2001	28.1	7.2
IRELAND	30.3	7.0
NETHERLANDS *	27.7	6.3
AUSTRIA 1998	25.5	6.2
*FTE as exception to HC. SOURCE: EC She Figures 2003, DG Research, WiS database. Note that data not yet comparable between countries due to differences in coverage and definitions.		

The German-speaking countries of Germany and Austria again form a cluster in terms of representation of women in academia: the proportion of women full professors is among the lowest in Europe.

Turkey should be mentioned in this context because of its very high proportion of women professors from an international and European perspective: among full professors there were 21.5% women as early as 1996/97 (ETAN 2000, 10). However, Turkey has an elitist higher education system where class rather than gender is more salient segregating feature in academic recruitment. Only 1 % of women and 2 % of men attend university, and there is a significant gender gap (17.3 % in 1999) in illiteracy (Kahn 1994; UNDP 2001, see also Acar 1991).

A disciplinary analysis of gender distributions reveals further variation across countries. Nowhere in Europe and in no major disciplinary category does the proportion of women among full professors exceed a third. The highest proportion of full professors is found in Finland (Humanities: 33.2% in 2000) and in Portugal (Medicine: 30.2% in 1999). Generally, the highest proportions of women full professors are found in the Social Sciences in EU-15 countries and in Medical sciences in some new Member states such as Poland and Slovenia. Engineering and Technology is the disciplinary field with the lowest representation of women among full professors in all European countries from which data is available. Women comprise less than 7% of full professors in this field on average. In Poland, France, Iceland, Finland and Sweden over 5% of full professors in Engineering and Technology are women, whereas the proportions in Austria remain at 1.7% and in Belgium 1%. (She Figures 2003).

Comparative European and international studies on gender in academia

Only a few comparative studies have been conducted on women in academia and scientific research in Europe or more internationally. In an early European 12-country study[1] by Veronica Stolte-Heiskanen and her European colleagues (1991), special emphasis was put on the obstacles and opportunities for women to access positions of responsibility within science. Six general common gendered patterns emerged (Stolte-Heiskanen et al. 1991, 5- 8):

(1) The higher the status of a position in the hierarchy, the fewer women. In practice this means a lack of critical mass and lack of role models for women students. This pattern could be found "with depressing uniformity, irrespective of the country, type of research organisation, scientific discipline, or degree of feminisation of the field" (pp. 6-7).

(2) Women are increasingly entering the lower levels of academic posts. At all academic levels, the number of potentially qualified women exceeded that of women who were actually engaged in the scientific occupation in question.

(3) Aspects of gendered culture were highlighted such as the lack of female professors who could function as role models and speed up changes, and "women's lack of confidence coupled with exposure to the condescending attitudes of male colleagues" (p. 6).

(4) A fundamental contradiction exists (to a varying extent) between "the academic clock, the domestic clock and the research system clock" that has not been satisfactorily resolved (p. 7). The crucial early stages of an academic career usually coincide with the childbearing and childrearing age. This has not been much taken into account in the advancement structures of science.

(5) Women's relative invisibility in the scientific community was well documented in several studies from the participating countries. "Science is sometimes defined as a way of seeing things. Women still far too often constitute a 'blind spot' in the vision of the scientific community" (p. 7).

(6) The more the sector of science represents an "instrument of power" the less open its scientific community was for women (p. 7). Women were notably absent everywhere from higher leadership positions, both within scientific institutions themselves, and in the science policy and administration infrastructure.

These six gendered patterns: gendered hierarchies, increase in the proportion of women on the lower levels of hierarchy, gendered culture, contradictions between academic clock and biological clock, women's relative invisibility, and absence of women from highest leadership positions continue to be highly relevant even today and have been confirmed by later research and science policy reports from different settings (see, for example, Husu 2001; Lie and Malik 1996; ETAN 2000). Later developments have confirmed Stolte-Heiskanen's conclusion that "the scientific community as such is highly resistant to change" (p. 7).

In a comparative 17 country-study on women in higher education, including both European and non-European countries, Suzanne Stiver Lie and Lynda Malik (1994, 1996) found the smallest academic gender gaps in countries where "egalitarian traditions are combined with economic opportunities". This

[1] The countries involved were Austria, Bulgaria, Denmark, Finland, German Democratic Republic, Greece, Hungary, Netherlands, Spain, Turkey, USSR and Yugoslavia.

explanation appears, however, far from sufficient, because in their study, two significant exceptions for the rule were found in Western Europe: Norway and the Netherlands, both having relatively high academic gender gaps among the professoriate, as Table 1 indicates. Both Norway and the Netherlands are globally at the forefront in gender equality policies, within academia and more generally, and both belong to the most economically affluent group of countries in the world. The high level of overall gender equality in these countries is reflected in global comparisons as in the gender equality indicators of the Human Development Report of UNDP (UNDP 1995-2004). Both countries also have a well-developed Women's Studies infrastructure, supported by public policy for decades (see, for example, Blokdij-Hauwert and Hof 1999; Bull 1999; Mottier 2000; Soyland et al. 2000). As noted earlier, In Norway there is no gender gap among the population in tertiary level education attainment, and the attainment level of tertiary education has been generally high (Figure 1). Despite this, the gender gap in the professoriate in Norway is relatively large, and what is even more striking, larger than in many other European countries, in Northern America or Australia (Lie and Malik 1996, 198). In the Netherlands, the gender gap in the professoriate is in fact among the largest in the EU-25; only 6.3% of full professors were women in 2000 and the proportion in Norway (13.7% in 2000) is only around European average (see Table 1).

A recent comparative European study was conducted within the *Research and Training Network Women in European universities* in 2000-2003, coordinated by Annette Zimmer from Germany. The participating countries were Austria, Germany, France, Poland, UK, Spain and Sweden. The project included analysis of statistical material and interviews with over 3400 female and male professors. The study found a connection between the age and reputation of a university and its accessibility and openness to female academics in the UK and in Spain, women having better chances to be hired in the newly founded institutions. University professors, women and men, were found to be a homogenous social group, highly motivated for doing research. They had passed various career stages more or less at the same time regardless of gender. No significant gender difference was found in the scientific production (publications, chairing conferences, grants) or family background. Generally professors came from well-educated families in which both parents had a high educational level. Among female professors the rate of academic endogamy – having an academic partner – was striking, almost 50% of those who were living with a partner were married to a faculty member. On the other hand, compared to male counterparts, significantly more female professors live alone and do not have children. What was also different for women and men was perception of the university environment. "Female professors express feelings of burn-out, exhaustion and anxiety more often than their male colleagues. Female professors in the countries under study unanimously complained about the overload of work, specifically administrative work" (p.12). Furthermore, female and male professors disagreed about whether women are accepted in the scientific community. Male professors saw that their female colleagues are thoroughly appreciated and acknowledged in their departments and scientific community, but female professors "perceived themselves as being not accepted by their male colleagues" (p.12). Women and men agreed that women have to work very hard to get on in science and at the university. (*Women in European Universities* 2000-2003).

Variations in European gender systems

Variations in European gender systems are highly relevant when seeking to understand variations in educational attainment of women and men in Europe and development of gender equality in higher education. These variations can be discussed here only shortly.

Great variations exist in the *history of women's employment and participation in higher education* within Europe and this historical heritage should be taken into account when comparing the current situation between countries. European countries also vary in terms of when women were allowed to and started to enter universities in a larger scale and in the pace of the growth of women's participation. A closer look at Finland may serve as an example. Finland is a country with high tertiary education level of the working age population – in 2003 a third of working age population (25-64 years old) had had tertiary education. This was among the highest in the OECD countries after Canada, US and Japan, and at the same level as in Sweden (OECD 2005). More women than men have completed tertiary education, and the proportion of women among Ph.D. graduates and among full professors is at a relatively high level in European comparison. This current high representation of women has long historical roots. Finland had proportionally more female students in universities in the early part of the 20th century than any other European country (Elovainio 1971). In 1908, as much as 21.4% of students in the University of Helsinki (then the only University in the country) were women; similar levels were reached in neighbouring Norway and Denmark over 25 years later (Ståhle 1996). The historian, Eric Hobsbawm, has pointed out how after the Second World War, in most developed countries the proportion of female students was 15-30%, but in Finland their share was over 40% (Hobsbawm 1994). However, another example where an early start for women in higher education has not produced lasting equalizing effects is Switzerland. Switzerland pioneered in women's rights to higher education by opening in 1865 its universities for women as the first country in Europe when other European universities denied women entry (Abir-Am and Outram 1987). The intensity of tertiary education in Switzerland is high as seen in Figure 1, but so is the gender gap among the population with tertiary education in men's favour.

A second crucial issue to take into account when comparing the position of women in higher education and science in different European countries include *labour market participation trends and patterns* among women. Employment rates for women in Europe have increased, and in 2002, 55% of women in EU-15 were employed, ranging from around 40% in Italy, Greece and Spain to over 70% in Denmark and Sweden (Eurostat 2003). The full-time and part-time participation rates vary a lot within Europe: a third of all women in EU-15 countries worked part time in 2002. Part time rates were relatively low in Mediterranean countries and Finland, but very high (73 %) in the Netherlands. In the Nordic region – Denmark, Finland Sweden – women's labour force participation rates were highest in the EU-15 (from 67% to 73% in 2002). Of the Nordic countries only in Finland have women traditionally been employed mostly full-time; the part-time rate in 2002 was 17.1% in Finland but 31.4% in Denmark and 32.9% in Sweden. As noted earlier, Finland has higher proportion of women among Ph.D. graduates and professors than its Nordic neighbours. In Portugal, the country topping EU-25 statistics in the proportion of women of Ph.D.s and full professors, women have much higher labour force participation rate (61.2%) and lower part time rate (16.4%) than other Mediterranean countries (Eurostat 2003).

Family responsibilities are frequently presented as the main problem hindering women in their studies and academic career. However, how easy it is to combine academic work and parenthood depends to a large extent on *public provisions to support parenthood:* parental leave opportunities and financial compensation, child care provisions etc. In countries where public provisions are not developed, universities and research institutes may have developed their own provisions to support parenthood. The European countries differ in whether the society approaches parenthood and reconciliation of work and family as a private or a public issue to be supported by different provisions. Thus European women face very different situations depending on the country they live in, since provisions related to parenthood and children vary a lot in

Europe. There are countries like the UK and Germany where availability for day-care for children is rather limited, whereas in the Nordic countries the provisions are relatively generous (for example, on the policies and provision in Finland, see Ministry of Social Affairs 2005).

There is also great variation in how gender equality issues are placed on the political agenda in European countries in terms of both *ideology* and *legislation*. This is linked to women's political participation which shows large variation across Europe. From a regional perspective, women's political participation in the Nordic region (Denmark, Finland, Iceland, Norway, and Sweden) is the highest in the world; in 2005 the average proportion of women in the Nordic parliaments is 39.9%, whereas the global average is 15.8% and the European average (excluding the Nordic countries) 16.9% (IPU 2005). Norway had a female Prime Minister as early as 1981, Iceland and Finland have elected women as the President of State, and since mid-1990s, half of the Swedish Governmental Ministers have been women. Nordic societies regularly receive high ratings in international comparisons of overall societal gender equality development. Recent study by the World Economic Forum (2005) on empowerment of women and global gender gap concluded that "those that have succeeded best in narrowing the [gender] gap are the Nordic countries, with Sweden standing out as the most advanced in the world" (p.1). In this light it is intriguing that the Nordic region has not been more successful in narrowing the gender gap in academic careers.

Variations in University and Research Systems

Other large variations exist in Europe when it comes to the *position of universities* in society and the *research intensity*, measured by national investment in R&D. The university system, the research system, and academic promotion system, patterns of mobility, and composition and recruitment of gate-keepers also vary somewhat between countries. These structural features, seemingly gender-neutral, can have different impacts on women and men, and are equally important to take into account than explicitly gender-marked interventions in order to understand gender equality developments.

In terms of the overall position of the university institution in society, some intriguing East/West differences have been pointed out. In Poland, proportion of women among full professors is relatively high in a European comparison, as indicated in Table 1. However, the high proportion hides a reality which is not so rosy. The Polish sociologist, Renata Siemienska, has pointed out that with the transformation from socialism to a market economy the position of the Polish universities has deteriorated. Simultaneously, the proportion of women in university posts has increased. A brain drain from Polish academia, a drain abroad and a drain internally to the business sector, has been observed, consisting more frequently of male academics. Women have tended more often to stay in the university and thus their proportion has increased but at the same time their working conditions have deteriorated. Siemienska characterises Polish women academics as 'winners among the losers' (Siemienska 2000).

The proportion of research and development investment (R&D) of the gross national product (GDP) in a country is commonly used as an indicator for the relative weight of R&D in the national economy. In the EU-15, little less than 2% of the GDP was used for R&D in 2002, and with the new member states, the share was even lower, 1.8%. Of the European countries, Sweden and Finland used highest proportions of their GDP in R&D, 4.3% and 3.5% respectively. (OECD 2004). However, a closer look at Finland reveals that the business sector accounts for two-thirds of the R&D (2002), and within the business sector R&D, electro technology accounted for over half of R&D (56% in 2003) (Statistics Finland 2004). Taking into account that Technology is the field where men still are an overwhelming majority both among students,

graduates, Ph.D. graduates and researchers, it is obvious that seemingly high level investment in R&D in Finland has in fact gained rather male than female researchers.

Academic promotion systems, again seemingly gender-neutral, may include practices more favourable for men than women. Appointment systems should be screened from a critical gender perspective (for example, on the Finnish practice of professors by invitation, see Husu 2000, 2001). Mobility demands, age and time limitations in academic careers are in use in some European countries. An example from Germany is the principle of "Hausberufungsverbot", which means that one cannot apply for a professorship in the same university where one has obtained the Habilitation (post-Ph.D. degree) (see, for example, Krizio 1999). This kind of mobility demand can be difficult to realise for many women with family responsibilities. In some countries there are various age and time limits for completion or eligibility for grants. These kinds of time and age limitations negatively affect academics who take career breaks, and these are more often women. A debate about academic age versus biological age is emerging, but it is not very developed in all European countries. The concepts of ageism and sexageism are useful here. Ageism that is applied to women and men differently has been named as *sexageism* (Carpenter 1996, 142) or *gendered ageism* (Itzin and Philipson 1995, 88). Women can be perceived as being "older earlier" than men. According to a study on age barriers at work in local government and private sector (Itzin and Philipson 1995), it was generally men rather than women that thought this was the case. The intersections of age and gender in academic careers would be very important issue to address systematically both at national and European level.

The absence of women from high decision-making positions in the scientific community was identified by Stolte-Heiskanen et al. in their early 1990s study. The situation has not radically improved since: in the end of the 1990s, the decision-makers and gate-keepers in academia in Europe are still predominantly middle-aged men (ETAN 2000; see also Husu 2004). Some interventions have been effective here. The comprehensive EU Report *Science policies in the European Union – Promoting excellence through mainstreaming gender equality*, better known as the ETAN report (ETAN 2000) gives credit to Finland and the UK for progress in increasing women's participation in important scientific committees. For example, in Finland, the Gender Equality Act from 1986 was amended in 1995 by a quota paragraph that stipulates that in all public bodies there must be at least 40% representation of both genders. The effect of this is that the National Research Councils (the national research policy body and major research funding agency, appointed by the Finnish Government) became gender balanced in their composition. However, the Equality Act did not oblige private foundations which fund research to reach gender balance on their boards (see Husu 2004). The same trend can be found in other EU countries as well. The ETAN report (2000) points out how several private charities providing large amounts of funding for medical, for example cancer research, have no women on their boards of trustees, scientific advisory board or medical advisory board.

Promotion of gender equality in academia and research

Promoting gender equality in academia and scientific research is currently strongly on the agenda of various stakeholders nationally and internationally (see ETAN 2000; Harding and McGregor 1995; Rees 2002). This has occurred in universities (see, for example, Fogelberg et al. 1999; Higher Education in Europe 2000; MIT 1999), the national research councils (see, for example, Academy of Finland 1997, 2000; Trojer 2002), high profile science journals (Nature 1997, 1999; Science 1994, 2000; Wennerås and Wold 1997) and international intergovernmental organisations: United Nations (UN Beijing Declaration

and Platform for Action 1995) and its specialised agencies as UNESCO (Harding and McGregor 1995; UNESCO 1995, 1999), and especially in the European Union.

Active and increasing co-operation between gender equality advisers and activists, researchers and administrators in European universities has been developed since the end of the 1990s in terms of the *European Network on Gender Equality in Higher Education*. Four major European Conferences on Gender Equality in Higher Education have been organised as a result of this co-operation (in Helsinki (1998), Zurich (2000), Genova (2003) and Oxford (2005)). The core of the network between the conferences is its email discussion list, EQ-UNI list, with over 350 members from Europe but also other continents.[2]

In European science policy, mainstreaming gender equality in academic and scientific organisations is seen not only as an important goal which would enhance individual women's opportunities to use their potential. It is also seen more generally as a way to promote excellence. Promoting gender equality is increasingly seen as quality assurance ("equality equals quality") (EC 2004; ETAN 2000). The agendas and intensity of these activities obviously vary between European countries as does the size of the gender gap. There are countries with decades of gender equality activities in higher education and research, backed up by the national governments; countries with relatively recent but very active measures in this field; and countries where the issue is only rising on the agenda. The European Commission *Women and Science Unit* has since the late-1990s played a vital role in this development by launching the issue of gender equality in science and academia at European level through large conferences, thematic reports (e.g. on women in industrial research and women in research in Central and Eastern Europe and the Baltic countries), targeted calls, support for networking of women scientists (see http://www.epws.org), development of gender statistics and policy documents (see http://europa.eu.int/comm/research/science-society/index_en.html for more information on the European Commission Women and Science activities and to download documents).

A useful report, monitoring the situation in the EU countries has been produced with the help of the *Helsinki Group of Women and Science*, a group of national civil servants from 30 European countries, itself also an initiative of the European Commission Women and Science unit. The report *National Policies on Women in Science in Europe* (Rees 2002) provides an overview on equality measures employed in the member states and in associated countries.

The report observes that there is a considerable diversity among the countries in terms of equality measures and the climate for women seeking to pursue scientific careers, but also diversity in scientific infrastructure. Common factors include the lack of gender balance in decision-making about science policy, and among those who determine what constitutes ´good science´ (Rees 2002).

Many European countries have developed measures to support women in research and academia, and especially the Nordic countries have adopted gender mainstreaming approach: the systematic integration of gender equality into all policies and programmes and organisations and their cultures. The equality measures in Europe range from legislation to gender equality and gender/women's studies infrastructures, gender quotas and targets, to gender equality planning. The main types of measures include the following:

- *equal treatment legislation* (all EU-15 countries, most EU associated countries)

[2] The EQ-UNI list owner is the University of Helsinki. The list moderators are Liisa Husu (liisa.husu@helsinki.fi) and Terhi Saarikoski (terhi.saarikoski@helsinki.fi) who can be contacted for instructions on how to join.

- *statutory sex equality agency* (all EU-15 countries, around half of the associated)
- *Ministry for Women* (nine EU-15 countries, one associated)
- Women and Science Unit in the Science Ministry (6 EU-15, 5 associated)
- *Commitment to gender mainstreaming* (majority of both EU-15 and associated)
- *Sex-disaggregated statistics* (majority of EU-15 and associated countries, but not gathered in Belgium (Fl), Ireland, Italy, Czech, Estonia, Latvia, Poland)
- *Gender balance quotas in public committees* (minority of EU-15: Belgium [Flemish-speaking], Germany, Greece, Netherlands, Finland, Sweden, in associated countries: Iceland, Israel, Norway)
- Gender balance quotas in university/research institute committees (three EU-15 countries, one associated country: Norway)
- Gender balance targets on university/research institute committees (7 EU-15 countries, two associated)
- *Development of gender equality indicators* (majority of EU-15 countries, seven associated)
- *Women's Studies taught at Universities* (all EU-15 countries, majority of associated countries)
- *Gender Studies taught at Universities* (majority of EU-15 and associated countries)
- Universities/Research Institutes produce *gender equality plans* (8 EU-15 countries, one associated country: Norway). (Rees 2002).

Furthermore, positive action measures used in some European countries include supporting networks of women in science; mentoring programmes; numerical targets; earmarking chairs; funding of science prizes for women or girls; developing transparency in recruitment and promotion processes; raising awareness and equality training; gender-proofing policies and practices; gender proofing pedagogy of science education; and measures to facilitate work-life balance. (Rees 2002).

Thus far, there is a general lack of long-term evaluations of many gender equality measures, and thus, it is hardly possible to give thorough research-based answers to the question which measures work, which not, and in which circumstances and settings. Even if there are countries in Europe which have employed gender equality policies in higher education, academia and research for decades, such as Norway, the Netherlands, Sweden and Finland, we still lack thorough comparative research-based evaluations on the successes and failures of these policies and measures.

The large gender gap in higher education and research in German-speaking countries has prompted various active measures to improve the situation (on Germany, see, e.g. Krizio 1999; Müller 1999, 2000 and http://www.cews.de; on Austria, see, e.g., Hey and Klemmer 1999 and on Switzerland, see von Sahlis 2005; on all three, see also Rees 2002). Despite these activities, the changes have been slow and academia in the German-speaking countries remains among the most male-dominated in Europe. It has been claimed that the case of Germany and Austria proves that gender equality measures do not work. This interpretation is to my view too simplistic. It is not taking into account the large size of the gender gap and the gender system of these countries and the slow pace of change towards gender equality in general.

The Swedish case is especially intriguing. The Swedish government, being gender balanced since mid-1990s, has – I would claim -- probably the best gender equality rhetoric in the European Union. Various positive action measures have been adopted since the 1980s and more so in the 1990s, as with, for example, ear-marked professorships for the under-represented sex (see Jordansson and Shands 1999), governmental targets for increasing the proportion of women in the professoriate, gender equality planning in universities, and a state-funded national secretariat for gender research (http://www.genus.gu.se/).

Despite this, the proportion of women among full professors in Sweden is only at an average EU-level and has been increasing only very slowly. Even if Swedish society has been rated as the most gender equal in the world, academia in Sweden remains a male-dominated arena. The Swedish case demonstrates the complexity of gender equality promotion in academic settings; political will and active institutional policies are certainly necessary but not sufficient to induce rapid changes in gender balance in academia.

It is obvious that countries with long-term active gender equality policies in higher education and research do not necessarily fare best in women's advancement in academia and scientific research. But this does not necessarily indicate that gender equality policies are useless and would have no effect. Rather I would like to suggest that the slow pace of change tells us something about the dynamics of the deeply entrenched gender system and gender culture of academia, and (often latent) resistance, and hidden and covert forms of gender discrimination in academia (see Husu 2001, 2005). We need more qualitative, quantitative and especially comparative European research to understand the issue of gendering of academia in different national contexts. The role of gender research is pivotal in promoting gender equality in higher education and science. Gender studies is taught in nearly all EU countries, but there appears to be rather a large variation in the degree policy makers in higher education and science policy are listening to gender researchers. Also the EU-report on national policies (Rees 2002) stresses the importance of more research to understand the dynamics of gender in higher education and science in order to inform policy making in this area. The report underlines that gender research can be used to benchmark and critically evaluate positive action and mainstreaming policies, and gender research should be supported to understand better the gendering of science, scientific education and pedagogy, as well as scientific careers. In addition, a series of tools should be developed to evaluate and monitor equal treatment, positive action and gender mainstreaming measures designed to promote gender equality in science and scientific careers. (Rees 2002, 23-25).

Important themes deserving more attention of future research are gender analysis of seemingly gender-neutral policies and practices in academia; academic masculinities and men's perceptions of gender equality (see Hearn 2004), academic management and leadership from gender perspective and the complex dynamics of active and passive resistance against gender equality interventions within universities and academic institutions.

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University choices for women

Or:

Why (not) become an engineer?

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Abstract

Research conducted in Work Package 2, concerning engineering studies, deals with discovering and identifying the key stages of choice for entry to higher education, and the impact of different factors and opportunities for intervention. The fact that everywhere in Europe Secondary Education is open equally to women and men does not mean women and men make the same choices, in particular in the technological field.[1] And the fact that women do very well at school does not mean they consider they can choose any training.[2] Why, when, and how do students choose engineering or not? What could influence those students, male or female, choosing engineering or not? What could be the solutions?

Almost all of them declare engineering is a positive choice based on three points: Interest for techniques; concern for environment; promising job prospects and social status.

Influences: students admit that their choice has been heavily influenced by their family and their friends. It is interesting to notice that the main influence does not come from the school. Most of the students choose a subject but they insist on the fact that combination of subjects – when offered – is something positive (Germany, UK).

Why do students who could choose engineering decide not to go into it or why do they drop out? It is essential to understand those reasons because, by doing so, we can define clear ways for action. Even if by many aspects engineering studies (student

[1] MOSCONI N. (1989) « La mixité dans l'enseignement secondaire, un faux semblant? », PUF, Paris ; JONSSON J. (1999) « Explaining Sex Differences in Educational Choices », in European Sociological Journal, Vol. 15 N° 4, p. 391-404

[2] BAUDELOT C., ESTABLET R. (1991) *« Allez les filles »*, Seuil, Paris

motivations, institutions and teachers, pedagogical systems) are different, we can underline that some aspects are similar, so recommendations for action could be put into practice widely.

Information concerning engineering studies and jobs has to be improved in particular for women who are more preoccupied by the question of professional and personal life balance, they want precise answers about actual conditions of work. The gap between secondary education and higher education has to be questioned and reduced. Students ask for more classes based on dialogue, on exchange, on direct contact with other students and teachers. (peculiarly a woman's concern)

Personal contacts are obviously more important than any other source of information. Students mention as the most important ones – massively and essentially – the influence of their family and their friends.

The first cycle (the first two years) is obviously everywhere, in every country, the decisive time for students; if action is decided it has to take place in the last year of secondary schools and/or (depending of countries) during the two first years of higher education. In countries like UK where school pupils choose to specialise in subjects for national exams at about age 13, intervention must come sooner. A positive image of women involved in technology and doing well, being successful and happy with their jobs, has to be developed and promoted.

1 Introduction

The research work in that part called Work Package 2 aims at understanding the internal and external factors which influence women's choices towards engineering. Consequently we will basically deal with three questions: when, how and why do young women decide to choose or not to choose engineering studies?

We know that there are traditional explanations for the low number of women in engineering: social determination on one hand (= anthropological determinism about role of women defined as the person in charge of children and house care, school system of orientation, assimilation of science and technique to masculinity, absence of women icon in the field) and women's adaptation to objective social conditions on the other (= lower salaries for women, reluctance from industry to hire women, difficulty to balance professional and personal life, difficulty to get promotion to level of responsibility...). We decided to explore both kinds of explanations and to design hypotheses which could cover the field as widely as possible.

The second principle we adopted was to ask actors of the field and to listen to them. First students, women and men, with two different groups, one of students in technology (women and men in same quantity) and another one with students who could have become engineers with different situation depending on countries: either students who had started studies in the technological field and dropped out (in countries where drop out is high), or students who could have chosen engineering considering their choice of sciences in high school and the level of their results but decided not to go into engineering. In both cases we want to understand why they decided that way. At every step we believe the possible comparison between the four samples could give us clues and answers. We had the conviction that if we could see clearly their reasons to drop out or not to start such studies we could design tools to support some of them to make another choice.

The methodology for understanding what students think is to use questionnaires in order to gather quantitative data, interviews and focus groups in order to have their words, their thoughts.

There are other actors in the field who have different points of view on the same questions. We decided to interview teachers/professors who work in institutions which are dedicated to engineering, persons responsible for training in the same kind of institutions, equal opportunity officers when they exist, and persons in charge of counselling students when there are some. Another principle was to have both women and men interviewed; we wanted to see if there are differences in the way they analyse situations, in the way they imagine solutions.

We used several methods ("technical" tools) classical in sociology for this kind of enquiry:

semi directive interviews using guidelines with precise questions referring to WP2 (reasons for choices), WP3 (success and non-persistence) and WP4 (organisational culture and social change). Such a choice conducted us to write rather heavy questionnaires and guidelines with quite a lot of items, the advantage being that in one interview it was possible to get information and reaction on many subjects and to gather many points of view on our subject.

Focus Group organised according to guidelines written by the consortium: one focus group with only women students and another one with only men students. Again the choice was made to ask questions for WP2, WP3 and WP4.

Participant observation: classes were observed according to guidelines.

Web site analysis: the idea was to detect the presence – or absence of women – in school images, class room representation, specific information for women, gendered data concerning the staff and students.[3]

2 How to become an engineer: key decision moments across Europe

Synthesis and General Commentary

At first sight there appear to be considerable differences across the systems in the seven highlighted countries, but closer examination reveals some common features, once the predictable differences in nomenclature have been discounted. We will keep in mind that the word "engineer" used all over Europe does not mean exactly the same think, does not refer to the same historical reality, to the same social position and not even always to the same competences[4]. For example, in all countries students typically make the transition to higher education at age 17-19 and people qualify as "engineers" around the age of 22 – 26. Within each country there are several different ways to become an engineer which adds to the confusion. Indeed, the differences within a country, especially a large one like Germany with a considerable amount of local autonomy, may mean that there is greater diversity within a country than between it and its neighbours. However, to identify 'key moments' we must return to the start of schooling.

Early choices

[3] For more information about methodology see "*Methodological tools for research in gender and technology*", *POURRAT Y., (*2005), Editions ECEPIE, Paris,

[4] For example in Slovakia there are such specialties as "engineer in economics" which do not exist in some other coutries; in some countries architecture is a part of engineer, and not in other countries etc . . . ; boundaries of definition are not the same.

Children in all seven countries attend some form of common primary schooling from age 4½ – 7, and in some, continue through to the minimum school leaving age in comprehensive all inclusive schools (for example in Scotland[5] and Finland) while elsewhere the choice of a particular type of secondary (high) school is made somewhere between age 10 (Germany) and 14 (Slovakia, Austria)[6]. The type of secondary school attended can have a significant impact on a student's final career options, as for example in Germany. It is not clear how children are allocated to the different types of school in those countries where they exist. It seems obvious that parents must be involved in this important decision affecting their offspring's future life chances and one wonders how well informed they are about the consequences of making the different choices. This is clearly a key stage for intervention with advice and information about the potential impact on future careers of making the wrong choice at this time.[7]

In those countries where comprehensive secondary education prevails students select subjects for more in depth study after perhaps two years of secondary schooling at age 13 or 14 and stop studying others. This too can be a very important key decision moment because students who fail to study the necessary mathematics and science subjects beyond this point find it extremely difficult to pick up these subjects later and consequently do not have the entry qualifications for degree courses in engineering. Again, parents are likely to be involved in the choice of subjects. However, the influence of teachers and peers may become increasingly important the later these choices are made.

Transition to further and higher education

In all countries this typically occurs at ages 17-19 although there is scope for more mature entry in some places. There are different routes into engineering at this stage. In all countries there is an **academic** route where well qualified students follow a fairly theoretical degree course in engineering or sciences for three, four years or five years. Additionally in all the partners countries there are other way to become engineer more or less easy, more or less long. Our study concentrates on the academic way, students who have been interviewed are all in the academic track.

Post first degree

Gaining a first degree in engineering is insufficient in most countries to gain professional recognition as an engineer. In some (e.g. Slovakia, UK, France, Germany) a master's degree is required. Others follow set programmes laid out by engineering institutes People who do not receive professional recognition immediately as a result of their academic qualifications may achieve it after a period of professional employment.

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[5] It should be noted that the school system in Scotland is separate from and different from that in other parts of the UK.

2 Throughout we are considering state educational provision in the school sector and not any additional private provision.

[7] The primary and secondary school age was defined as out of our research field even though it is obviously very important as our inquiry show: most students decide what their studies are going to be at a rather early age, much before they enter higher education. See DURUT BELLAT M. "L'école des filles. Quelles formations pour quels rôle sociaux? » (1990), L'Harmattan, Paris,

These key moments are the same for both men and women and it seems likely that the earliest key moments are the most crucial as it is hard to change track. Who is advising school pupils about future careers when they have to make those first vital choices and how informed are those advisers?

3 Listening to students and experts. Interpretation of results

We have several kinds or results which have been distinguished in the different reports (qualitative data with interviews of students, experts, teachers, persons responsible for trainings; quantitative data with questionnaires given to students in engineering) but considering their consistency and coherence we will globalize them here. When a distinction has to be made we will precise it.

3.1 Why do women (and men) choose engineering?

The family

One interesting point is to check the social origin of students in engineering and drop out students or students who could have chosen engineering and decided not to go into it.

Social background is an essential aspect we have to look at, the hypothesis being that the level of education of parents is of primary importance and constitutes a key factor to understand why and how young men and young women decide what they want to study. [8]

*Education of parents for **women**: father*

Women Q1	France	Germany	UK	Austria	Slovakia	Finland	Greece
engineer	18,9	26	16	5,9	26,5	20,3	15
Higher education	39,7	42	26	38,2	20,4	25,5	52,5
total	58.6	68.0	42.0	44.1	46.9	45.8	67.5
Women Q2							
Engineer	18,2	14,3	24,4	3,4	22,4	12;8	0
Higher education	60,6	55,1	21,9	53,5	28,6	26,8	75
Total	78.8	69.4	46.3	56.9	51.0	39.6	75.0

[8] Such a question has been widely studied for the last 30 years or so. It is enough to mention the very famous book by Bourdieu and Passeron *Les héritiers*, 1964, Editions de Minuit, Paris. Lots of work has been conducted following that trend in the past decades. So we know from previous studies, without any doubt, that the level of education of parents is a key factor at least in France.

Q1 refer to students in engineering, Q2 to students who quit or who could have chosen engineering, in the analysis they will be called "Non Persistent, (NP)". "Higher education" and "engineer" were distinguished in the questionnaires so they have to be added.

We understand here "Higher education" as every kind of training after the end of high school, which includes first cycle, second cycle and third cycle of higher education.

*Education of parents for **men**: father*

Men Q1	France	Germany	UK	Austria	Slovakia	Finland	Greece
engineer	18,5	28	21,4	15,6	26,5	14,1	27,5
Higher education	52,8	44	28,6	28,9	20,3	38,1	11,5
Total	71.3	72	50	44.5	46.8	52.2	39
Men Q2							
Engineer	18,2	15,7	31,3	1,8	11;8	7,1	3,1
Higher education	60,6	39,3	25	58,1	29,5	24,9	56,3
total	78.8	55	56.3	59.9	41.3	32	59.4

*Education of parents for **women:** mother*

Women Q1	France	Germany	UK	Austria	Slovakia	Finland	Greece
engineer	3,8	12	2	0	10,2	5	10
Higher education	69,9	52	36	44,2	20,4	33,9	47,5
total	73.7	64	38	44.2	30.6	38.9	57.5
Women Q2							
Engineer	2,5	6,1	4,9	0	16,3	2,3	0
Higher education	80	55,1	36,6	60,3	30,6	24,5	56,3
Total	82.5	61.2	41.5	60.3	46.9	26.8	56.3

*Education of parents for **men:** mother*

Men Q1	France	Germany	UK	Austria	Slovakia	Finland	Greece
engineer	0	8	10,7	4,4	14,3	4,2	10
Higher education	54,7	62	19,7	33,4	16,5	32,4	47,5
total	54.7	70	30.4	37.8	30.8	36.6	57.5
Men Q2							
Engineer	0	3,9	6,3	0	3,9	0	3,1
Higher education	50,7	56,9	43,8	57,7	23,6	17,8	43,8
Total	50.7	60.8	50.1	57.7	27.5	17.8	46.9

Comments

The number of fathers identified as engineers is much higher than the number of mothers. It is easily understandable because a generation ago the percentage of women in engineering was even lower than today so it is remarkable that the percentage of women is significant: ex. in Germany 12% of mothers of women studying engineering are engineers ; in Slovakia 16,3% of mothers of women NP are engineers ; 10% in Greece ; 10% in UK for mothers of men studying engineering.

Globally the level of education of our samples is extremely high compared to the average level of education of the population in the different countries particularly in France and Germany. In France, Germany and Finland more than half of the fathers of engineering sons have completed Higher Education and in the other countries it ranges from 40 – 50%. In France 78% of men students NP have a father who attended higher education and 82% of mothers of women "Non Persistent"! 72% in Germany for fathers of men in engineering. But we can see strong differences between countries involved in the survey: In Finland 26,8% of mothers of women NP have attended higher education, 38,9% of mothers of women in engineering went to higher education.

In several countries, France, UK, Finland, the fathers of **engineering daughters** are less likely to have completed university education than the fathers of engineering sons. Slovakia, Germany and Austria make another group where the fathers are equally educated while Greek fathers of engineering daughters are more highly educated than of engineering sons.

If we look at the situation for women engineering students, we find that in Germany, UK, Slovakia, Finland and Greece the fathers of **engineering student daughters** are more likely to have completed a university education than the mothers, while parents of Austrian engineering daughters are equally likely to have university degrees. In this group the striking result is that in France the mothers of engineering daughters are much more likely to have a university education than the fathers, the situation we find for fathers and mothers of Greek engineering sons.

In each of France (20%), Germany (25%) and Slovakia (25%) male and female students are equally likely to have an engineering father. In the other countries there are more sons than daughters of engineering

fathers, especially in Austria and Greece Overall, with the exception of fathers of Austrian daughters, a high proportion of fathers of engineering students are engineers showing a positive influence on the children's choice of study and career. Many students surveyed indicated other family members were engineers, for example grandfathers, uncles, brothers and occasionally sisters indicating a wider influence from family than these charts suggest.

If we look at the case of France in detail, the fact that the mother went to higher education seems to be decisive for daughters, especially NP daughters. 58% of engineering daughters have a father with a higher education (but among them 18,9% are engineer) compared with 78.8% of fathers of NP daughters. 73,7% of women studying engineering (82,5% of NP) have a mother with higher education with "only" 3,8% being an engineer.. This is not true for men: less of them have a mother with such a level of education (54 and 50%) compared with 71,3% and 78,8% for engineering sons and NP sons respectively. So, engineering daughters have more highly educated mothers, engineering sons more highly educated fathers. NP sons and daughters have equally educated fathers but the mothers of NP daughters are the most educated and their fathers the least educated. It means that social determinism is linked to the level of education of the same gender parent. (DURU BELLAT M. "L'école des filles. Quelles formations pour quels rôles sociaux?", 1990, L'Harmattan, Paris; GADEA C., MARRY C. « Les pères qui gagnent: descendance et réussite professionnelle chez les ingénieurs », in « Travail, genre et société », N° 3, Mars 2000)

In Germany men who study engineering have the highest % of fathers with a degree in engineering (28%) and higher education:72%. In Austria there is no huge difference between men and women and between fathers and mothers. In Slovakia the level of education of fathers is higher than the level of mothers. In that case the fact that the mother is an engineer does not help – or encourage – for choosing engineering: 16,3% of women NP have a mother engineer!

Having a father engineer is obviously a factor for choosing engineering: from 27,8% in Greece or 28% in Germany to 14,1% in Finland the score is always high. Surprisingly we can notice that it is sometimes even more true for men who did not choose engineering, like in UK (31% versus 21,4%), in France the percentage is exactly the same. The case of UK is an exception: it may mean that the job is not so enviable! In France it means that men students who have a father engineer during secondary school choose science as their major and decide afterwards not to go into engineering.

It is very interesting to look at the overall extent of higher education between the groups of engineering and non-engineering students. Almost all groups of parents of NP students in France, UK, Austria and Slovakia and Greek fathers are more educated than the corresponding parents of engineering students. In Germany and Finland and for Greek mothers, the parents of engineering students are more highly educated. This could be an indication of the high status of engineering in these countries.

In conclusion to those few remarks we observe that the situation is very different from one country to another, the importance of having parents with higher education is deeply variable. Of course the interpretation of such facts is not always easy because particular situations and particular history make comparison difficult (for example the fact that in France 4% of students study engineering and 33% in Slovakia make comparisons tricky!). One fact is obvious: the father engineer is a role model for lots of men and, in some countries, even more so for women.

We must also take account of the national situations when interpreting the results. For example in UK there was a major expansion of Higher education in 1992. Before that time many women training as

nurses or primary teachers went to specialised colleges which awarded diplomas and many men trained as engineers receiving a Higher National Certificate or Diploma from a college or polytechnic. After 1992, these levels of education were incorporated into University provision so low figures for the percentage of university educated parents may represent increased social mobility for the children or may be a reflection of significant social change.

The point of view of students

When asked what the role of their family has been in their decision to chose engineering they emphasize the importance of the support they received from their family, with the noticeable exception of Slovakia as it appears in the following figures.

	Total		Total				Austria				Finland				France			
			Male		Female		Male		Female		Male		Female		Male		Female	
	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father
Discouragement	17,8	15,1	15,8	13,9	19,5	15,7	9	11,3	18	15,2	4,8	4,8	1,9	4	3,9	0	12	5
Encouragement	56,6	58,8	53	58,6	60	59,3	56	46	51	57,6	75	68,7	74	68	62,8	66	71	59

	Greece				Germany				Slovakia				UK			
	Male		Female		Male		Female		Male		Female		Male		Female	
	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father	Mother	Father
Discouragement	8	5,6	11	11	8	2	8	10	71	66,7	67	61	1,8	9	8,2	4
Encouragement	54	80	56	59	62	73	82	74	2	2,1	4,1	4,1	64	71,5	77	77,5

Interviewed students confirm those figures. French student say: “my parents had a lot of influence on me”, “my father is an engineer; he has influenced me a lot. My mother wanted to study engineering but did not do it because of the sexism of the faculty at the time”, “my father made me meet students in engineering”

In Austria: ”my father supported me”, for another student an uncle was a role model;

In Scotland it is the same: ”my father has worked as an engineer, he was a role model, he influenced me”; “cousin and friends were supportive”.

In Germany none of the students mention a role model from family but all of them talk about “strong support” “permanent support” from their family”, one woman says:”my father always wants me to talk about civil engineering”.

With the possible exception of Slovakia all the students underline the importance of the family, relatives and friends support. It seems essential for successful studies in engineering as it is probably the case in every kind of demanding studies.

Teachers in high school seem to play a role, sometimes a very important one (France, UK.)

Booklets or other kind of paper information are never mentioned and web site is mentioned once. Counsellors do not seem to be influential, they are ignored by students.

Interest in the subjects:

All the students questioned and/or interviewed declare a high interest in sciences and technology without any difference between men and women. There are numerous declarations from all students in every country. In Germany: "I wanted to do something with technique" (4 times); in Austria:" I was very good at applied maths. . . I liked maths, physics, astronomy, I used to play with Lego techniques . . . I preferred science subjects at school. I had a special interest for puzzling, chemical construction"; in France: "I chose physics very early at 15" . . . "I was very interested in physics so I decide to become an engineer at 17. . .; in Scotland: "I did a lot of computing at school . . .I have always wanted to study biochemistry. . .I enjoyed maths and physics. . .I have always enjoyed physics, maths and chemistry and technological studies" ; in France: "I have always been interested by knowing how things work, how nature is organised, I wanted to design objects. . .". Such an interest comes very early, much earlier before students enter higher education.

If we consider that criteria differences between countries are small or non existent. Which is different from other factors we are going to examine now.

Jobs, salary, open opportunities, prestige

Women and men mention rather often the fact that engineering is a good way to find a job, usually well paid, interesting and socially well considered. Women students consider engineering gives opportunities to women. Then there are some specific factors connected with some particularities of such and such country. For example in Germany, UK and Austria the fact that engineering can be combined with other subjects is mentioned as attractive, in France a diploma of engineer opens doors not only in the technological field, or the fact that the school system "pushes" good students to preparatory classes.

3.2 Why do women (and men) do not want to go into engineering?

Mistrust of sciences and technology

Our hypothesis was that some students are sceptical about science and technology and do not believe they can be a significant contribution to the progress of humanity. The second step in our hypothesis was young men and women do not choose engineering because they are afraid of some consequences of technological development, third step we assumed that women have the tendency to be more sceptical, more critical than men and such an attitude could be a reason for them not to choose technology.[9]

What about answers students give to the question: "Do you agree with the opinion that science and technology are essential for the progress of humanity?". The analysis of answers shows that young men and women in Europe are largely positive regarding the capability that sciences and technology have to be essential to the progress of humanity. Overall only 4,8% of students are sceptical (totally disagree or disagree) and 83 % agree or strongly agree with the sentence.

[9] Such an hypothesis was based on the fact that a certain tradition in the intellectual life of Europe has been strong for quite a long time and students are sensitive to the environmental problems and the responsibility of technology in it. From HEIDEGGER *"question concerning technology anf other essays"* 1977, translation by W. Lovitt, to RiICOEUR "ce *qui nous fait penser la nature et les règles"* 1998, Odile jacob, Paris, to MARCUSE H. "*Technology being responsible for the One dimensional modern man"* 1964, Ark Paperbacks, or SALOMON J.J. *Survivre àla science" 2000,* Albin Michel, Paris.

What is even more interesting regarding our research and our hypothesis is the fact that men are slightly less positive than women. We could have expected the opposite, the common assumption being that Women are supposed to be more concerned with environment, they are supposed to be more attentive to the future and to the dangers that science and technology could represent. Regarding such a criteria we can observe three situations:

1- sometime women are more positive in their judgement than men ; if we add the numbers 4 and 5 (the two highest degree of positive answer) we can see that in France (84,7% of women Students P, 75% of women NP can be compared to 69% of men P and 72% of men NP); in Greece (72 and 78 can be compared to 82 and 84,4); in Slovakia (75 compared to 87 % for students P) women are more optimistic.

2- Another group of countries show the opposite: Germany (82 and 90 for men compared to 80 and 83% for women); Finland (87 and 82% for men compared to 70 and 84% for women); Austria has small differences (88 and 80% for men compared to 90 and 70% for women)

3- The last country is UK (87,5 and 81% compared to 81,3 and 85%) were the difference is so small that we can consider it is not significant.

Another remark which is, again, some sort of a surprise is the fact that students in engineering are more sceptical than students in other fields. This is the case in Slovakia with the widest difference (75 compared to 90%), in UK (for men only), in France, in Germany (only for men), in Greece (only for men), in Finland (only for women), the only country where students in engineering are more positive is Austria (for men: 88,9 compared to 80% for NP students, for women: 90 compared to 70% for NP students).

If we examine country by country such results we can observe some interesting facts: In France women who study engineering are more positive than men by a large margin: 15% ; men studying engineering are 10% to disagree with the sentence, which is the highest level in Europe, when in France men who do not study engineering are only 3% to disagree with the sentence. At the same time girls who have chosen engineering are only 1,9% to disagree with the sentence which very low. Is it because French students go into engineering because they can more than because they like it? Women having made a more positive choice agree very strongly with the sentence.

In UK we can observe that 5% of men students in engineering disagree with the sentence when 19% of men who do not study engineering disagree with the sentence which is by a large margin the highest level in Europe.

In Slovakia we can find a high level of disagreement with the sentence: 14,3% of men students in engineering disagree when women are only 4,1% to disagree. If we consider the four categories of our sample it is the country with the highest level of disagreement. Is it a heritage of the communist era? or the fact that engineering does not have the same kind of prestige one can find in other countries in Europe?

Austria is interesting because it is the country which could confirm a part of our hypothesis: women students who do not study engineering are more critical: 10,7% of them disagree with the statement when 0% of women who study engineering do so. Such a remark is not true for men (88,9% of students P and 80,8% of non persistent students).

Greece and Germany are in the average with a small difference between men and women, the latest being more positive in their judgement of science and technology.

We can conclude that the judgement regarding the fact that "science and engineering are essential to the progress of humanity" is obviously not the reason why young men and young women in Europe decide not to study engineering or not to go on with studies in engineering. It would be interesting to understand why students in engineering are more critical than other students.

If we try to understand why some students disagree with the statement we can read answers to the following question: "Sciences and technology are a danger for nature", 1 = I strongly disagree, 5 = I totally agree. We observe that differences between men and women are not significant. The interesting fact here is that the total of students who agree (= 19,5%) is significantly higher than the percentage of students who disagree in the preceding question (4,6%), which means that some students believe science and technology are essential for the progress of humanity but at the same time, consider science and technology are a danger for nature.

Another hypothesis: Do women suffer from sexism in engineering?

Could it be a reason why women do not want to study engineering? Is it true that technology is "a world without women" (NOBLE D. 1992)? The only women who clearly complain about sexist attitude in engineering courses and institution are some Austrian women. They declare that they had to hear remarks like: "You will never make it", 'If you did well it is probably because you cheated" or "You are too stupid to pass this exam". Technology departments are sexist, "there is a masculine culture, women are not welcome". One of them analyses: "The University is sexist: there are 50/50 women at the beginning, 70/30 as assistants, and 100 males as professors". They felt men do not want women into engineering because they believe they are going to take men positions, . . There is a power struggle". One student says she was not aware of sexism before she "discovered it in action".

Two students explain their drop out decision by the sexism they experienced.

Apart from Austrian students almost none the students interviewed complain about sexism. Most of them did not see any kind of difference between women and men.

The fact that they were a minority in technology courses does not seem to be a problem for most of them. On the contrary quiet a lot of them underline the fact that they liked it: in Scotland "they had no experience of sexist behaviour" ; in Germany they never "experienced a gender unequal treatment from male fellows", "I had no advantage or disadvantage of being a woman" ; in Finland: "belonging to a minority did not bother me", "I also got along well with boys, actually I got better friends from the boys", "(we) were equally treated by students and the staff. There was no special competition" ; in France: "(we) do not feel any kind of sexism from the staff. On the contrary a woman among a lot of men can take advantage of being a minority. In my views the best situation is 50/50 ; the atmosphere is different". A German girl says: "being a minority is not a disadvantage, I always prefer the company of boys"

Some students declare that boys "may be a bit more competitive than girls but it is probably more a question of person than a question of sex".

There are no complaints about fellows students, some women underline the fact that they have been helped by men in the lab and for practical work in general.

From the interviews which were conducted, apart from two women in Austria, sexism is not a major reason to drop out from engineering studies.

The question of femininity and engineering

The hypothesis is that the image young women and young men have of "femininity" does not go well with the idea of engineering and technology. In order to verify such an hypothesis students had to react to the following statement: "Sciences and technology suit men better than women"

1 = Strongly disagree, 5= strongly agree

In order to interpret the results we add the two negative lines (1+2) and the two positive lines (4+5)

Q1

Austria		Finland		France		Greece		Germany		Slovakia		UK	
M	F	M	F	M	F	M	F	M	F	M	F	M	F
51	88,2	33,3	64,9	63	92	44,7	65	40	74	47,9	51	39,4	65,3
17	11,8	24	26,3	13	3,9	18,4	10	22	6	18,8	16,3	14,3	18,4
13,3	0,	29	3,5	11,5	2	16,4	12,5	18	4	16,7	14,3	26,8	4,1
6,7	0	8,7	5,3	7,7	0	13,2	5	12	10	10,4	8,2	16,1	6,1
1,1	0	4,3	0	3,8	2	5,3	7,5	8	6	6,3	10,2	3,6	6,1

Q2

Austria		Finland		France		Greece		Germany		Slovakia		UK	
M	F	M	F	M	F	M	F	M	F	M	F	M	F
50	67,3	37	75,6	66,7	87	49;9	59,4	47	87,7	17	57,1	34	61
13,5	16,4	44	12,8	18,2	7,5	15,6	3,1	23,5	10,2	15,7	12,2	35	24,4
19,2	7,3	11,1	8,1	6,1	2,5	15,6	9,4	15,7	4,1	41,2	14,3	18,8	4,9
11,5	3,6	3,7	2,3	3	2,5	6,3	9,4	9,8	0	19,6	8,2	15,6	2,4
5,8	5,5	3,7	3,7	6,1	0	15,6	18,8	3,9	0	5,9	8,2	6,3	7,3

Comments

The first striking evidence is the fact that there are huge differences between the seven countries. There is always a majority of persons who reject the proposed sentence but it is done on very different ways: it goes from 100% disagreement in Austria for women who study engineering to 53% of men studying engineering in UK, or 33% of men who do not study engineering in Slovakia! (which does not mean that a majority agrees with the proposed judgement because lots of them did not answer that question).

It seems that the main difference here is between men and women and not between students in engineering and other students. But on that question, again, there are some heavy differences between countries. In Austria men and women disagree on their judgement by a margin of 32% (68% of men and 100% of women disagree with the sentence); in UK the difference is 23% ; in Germany 27% for students in other fields, in Slovakia 33% for students in other fields. There is, in such a case, a real difference of vision over the difference between men and women regarding the question of technology which seems to be made for men.

In France and Greece differences are much smaller: 10% difference for students in other fields, 3% in Greece for students in other field. It is tempting to conclude that the gender gap is smaller in those two countries; even if the vision is not the same in France and in Greece, they share that common point.

Actually the main difference comes most of the time from the fact that men do not want to answer the question, or cannot answer the question: the percentage of answers in the middle (number 3) which more or less means: "I do not know" (or:" I do not want to answer"!) is always higher for men, and is sometime very high: 41% of men in Slovakia chose number 3! By contrast there are only two countries where women chose number 3 at a significant level: Greece and Slovakia. Apart those two countries women

know about the question, the have a precise point of view. Regarding the refusal to answer the difference between men and women is: Austria 13% against 0%, 19,2% against 7,3% ; Finland: 29% against 3,5%, 11% against 8% ; France: 4,5% against 2%, 6,1 against 2,5% ; Greece: 16,5% against 12,5%, 15,6% against 9,4% ; Germany: 18% against 4%, 15,7 against 4% ; Slovakia: 16,7% against 14,3%, 41% against 14,3% ; UK: 26,8% against 4,1%, 18;8% against 4,9%.

We can suspect that men know but sometimes do not want to say because there are afraid of not being "socially correct". This is a point where very deep differences appear in Europe. Some countries have huge differences some other small differences which means men and women share a common vision.

There is an aspect which has to be observed very precisely because it corresponds to an hypothesis explaining the low number of women in engineering: we supposed that women have the idea that technology does not suit them. Such a "belief could be a cause of non choice or non persistence. In that case the difference between women students in technology and women Non Persistent could/should be significant. We can observe that only in Austria and in Greece this is the case. In Austria: 0% of women P and 9,1 % of women NP ; in Greece: 12,5% of women P and 28% of women NP. That difference can explain the fact that women do not want to go into engineering. The problem with such an hypothesis is that in some countries it is the other way around: in Finland 5,3% of women studying engineering believe it suits better men that women and only 3,5% of women NP ; in UK 12,2% and 9,7 ; in Germany it is the most spectacular: 16% of women studying engineering against 0% of women who do not study engineering believe that technology suits better men than women. It is the opposite of our hypothesis and cannot be a reason why women do not choose technology! There is a third group with France and Slovakia where women do not differ in their judgement over the sentence, being students in engineering or in other fields ; in France 2% and 2,5% ; in Slovakia: 18% and 16,4%.

The main point seems to be the difference among men in the seven countries regarding the proposed sentence. If we look at the judgement dearly (because positively) "sexist": "technology does suit better men than women", we have two kinds of countries: Austria, Greece, Slovakia, UK and Germany where a "high" (we consider as high when there is more than 20 of men who agree with the proposal) percentage of men agree, being students in technology or not: Austria: 7,8 % (students in engineering) and 27,3% (students not in engineering) ; Greece: 18% and 22% ; Slovakia: 16% and 25% ; UK: 19,7 and 21,9%: Germany: 20% and 13% (where students in engineering are more sexist than other students). Another group of countries exist with France and Finland: 11,5% and 9,1% in France ; 13% and 7,4% in Finland. In both cases men who study technology are more sexist than other students.

We can conclude that even if there are differences between countries it seems that the main factor is the divide – sometime the gap – between men and women over the proposed sentence: it is obvious that a huge and deep work has to be made to persuade people (men and women alike, even if it is at different levels according to the countries considered) that technology suit men and women on a comparable way. We realise that it is obviously an obstacle to women for attending engineering studies.

The same question from a different angle

Does you image of femininity fit with the image of a female engineer? Q1: 65 and Q2: 75

We will examine only the global answer without breaking down country per country. We add 1 (= not at all) and 2 ; and 4 and 5 (= Yes, very much)

	Q1			Q2		
	Total	Men	Women	Total	Men	Women
1 + 2	21,2	31	10,4	26	34.2	18,4
	30,3	33	26,4	32,7	35,8	30
4 + 5	48,5	34	63,2	41,4	30	51,7

We read again a difference between men and women and between women studying engineering and women NP. We can notice that even among women students in engineering only 63,2% believe the image of femininity fits with the image of a female engineer ; does it mean that 36% see it as a problem? Among female students NP one out of two does not think that femininity fits with the image of female engineer, which seems very high.

As far as men are concerned between men studying engineering and other men the difference is not important; they share a common vision of femininity which does not fit very well with the image on a female engineer.

The conclusion is obviously that this question of image is a major problem.

The image of engineers

Another hypothesis we wanted to verify is the idea students have about what it is to work as an engineer. What do engineers do? A negative image could well be an explanation to the fact that students do not go on with engineering studies or do not want to start them. Asking Non Persistent students we had a catalogue of traditional stereotypes, the view they have about what engineers do and how they work is amazingly stereotyped, even when (which is the case for most of them) they have spent several years studying technology: “an engineer is a male sitting in a dark chamber, spending all the time for working” (Finland), “engineer work is very lonely and women are more social persons than men. Usually women want to work with people and not with machines”, “ an engineer is a male, working alone in front of a computer, doing some calculation”(France); “engineer jobs are boring, it is only calculation, strength of material, structure . . . I want a profession with the possibility to use imagination, to be creative and engineering does not”.(a French woman studying business).

Plus the fact that sometimes students are afraid of the quantity of work expected from an engineer: “the work of engineers is pretty hectic and demanding”. One woman from Austria explains her decision to drop out because she realised that: “conditions of work for women engineers in companies are bad. . . (there are) difficulties to balance family life and professional life, salaries are lower for women”. That same person believes women are as able as men to do well in engineering but women have a clear awareness of objective difficulties in professional life for women in the field of technology. Women in Slovakia underline the fact that society identifies engineering and masculinity, “when they have a choice companies always pick up a man for a job and he gets a better pay cheque”. French women share those views: “when we think about technology we do think on men world, on man side, like toys, gadgets: they are Christmas presents for boys”.

By analysing those results we do realise that students who have been interviewed have different degrees of thought, different degrees of knowledge, concerning our question: some of them (girls in Austria are the

best example, but it appears too in Slovakia) have an analysis which refers to elements of sociology, they explain their decision to drop out by objective elements concerning inequality in society, and in particular in professional world. Their attitude is presented as an adaptation to objectives conditions. When some other women (Finland, Slovakia, some German women) prefer to stick to old stereotypes about a supposed divorce between women and technology (tools machine, male intelligence of technique . . .) and more rarely they mention a divorce between women and sciences (mathematics is mentioned several times as a problematic, a difficult field of knowledge for women).

All of them seem to agree on the fact that technology is harder for women than for men: ”we can make it but we have to work harder”.

Lots of women interviewed agree with the idea that “engineering is a masculine vocation” (ALEMANY C. “Is to be an engineer a masculine vocation? or the ambiguity of a change” in Women in Science and Technology”, (1990) Paris, UNESCO.

4 Ideas for action

From interviews of students, experts, focus groups, questionnaires we can gather some ideas for action. The ambition is to suggest solutions in order to attract more women (and maybe men as well, even if it is not our main concern in this work) into engineering or/and to convince them to stay in engineering. The recommendations:

Personal contacts are obviously more important than any other source of information: students mention massively the influence of their family, their friends etc. . . . There is a real and serious lack of information concerning engineering studies and engineering jobs Consequently a lot should be done directly though contacts with teenagers and through the influence of parents and teachers.

Everywhere women seem more concerned by a long-term vision of their life than men so meeting with successful women engineers should be developed, examples should be presented, the network of former students from the institution should be activated, networks of women engineers should be created if they do not exist. Role models should be presented (we could mention the role of medias in creating role models and the fact that engineers in general are globally absent from media producion, and women engineers even more so)

Women students are more preoccupied by the question of balancing professional and personal life, they want precise answers about actual working conditions, actual conditions of mobility, actual condition of promotion. Contacts and meetings with companies which have developed “good practices” should be organised.

Salary does not seem to be the main concern for students in general and for women in particular (That point can be cross-analyzed with expectations for a professional career: see article on Professional Sphere). Other aspects of the work of engineers should be emphasized (creativity, team work, contacts with people: partners or clients, intercultural aspects . . .)

The first cycle is obviously the decisive time for students everywhere, in every country. If action is decided on, it has to take place in the last year of secondary schools and during the first two years of higher education. (In countries where students select subjects at 13 or 14 for National exams action may have to take place sooner to ensure more pupils choose maths and physics) Contacts between high schools and higher education institutions should be improved (better awareness of what is expected from students,

better preparation to technological studies, better understanding of female concerns and expectations). Science and technology teachers in high school should be convinced that women can do just as well in technology than men in higher education.

Students ask for more classes based on dialogue, exchanges and direct contact with other students and teachers (a typical concern of women according to our inquiry). So a great effort should be done especially for first cycle pedagogy. In the same direction welcome events should be organised and tutoring developed. Faculty should be aware that the two first years are critical for some students (particularly girls) who have to be convinced that they can be successful if they are helped. Couselling should be developed and a top down policy has to be put into action in higher education institutions.

Monoeducational courses could/should be proposed when it is culturally acceptable and where it is judged productive (see the German example)

Conclusion

The first impression when one looks at the European system of engineering training is the diversity ; from Greece to Finland we can have at first the impression – the conviction – that nothing is similar. In fact after reading interviews and analysing answers to the questions we can see very clearly that some important aspects of the phenomenon we want to understand are similar. Today women are present in training for engineers experiencing a "silent and respectful revolution" (MARRY C. " *Les femmes ingénieurs, une révolution respectueuse "*, 2004) but the situation for them is still difficult, they have to fight against stereotypes they very often carry themselves. We know how things can be improved, women can be fully accepted and to get to the point where they will not be a minority but a significant group of persons giving to technology a new social awareness and a new social meaning.

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Success and Non-Persistence in Engineering Education

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Abstract

The paper will draw on hindering and supporting factors for persistence of women engineering students. It will be shown that in some cases country specific differences dominate over gender specific differences. Connections between self description and drop out thoughts, reasons for dropping out of engineering degree courses, coping strategies will be investigated. Supportive people and supportive factors will be identified and a set of recommendations will be proposed.

Over the last 30 years, a variety of initiatives have been set up to involve more women in the study of engineering. Earlier attempts focused primarily on young women and making them more informed. Subsequently, stronger emphasis has been put on changing and improving degree courses and the cultures of engineering institutions. It is in this context that the WomEng project is situated. The main question of work package 3 for the Higher Education sector was: "Once women have enrolled in engineering degree courses what factors affect their decisions to either persist or drop out."

It has been observed that drop out, rather than being a result of a lack of intellectual ability is dictated fundamentally by the discouraging climates found in the various departments, courses, and schools of engineering. For these women, contributing factors such as lack of practical experience, an alienating atmosphere, and weak to non-existent, non-specific faculty support play the decisive role in their decisions to leave.

It is vital for women to feel part of a larger engineering community. A sense of belonging is strongly linked to a student's self-confidence, especially for female students in a minority and in male dominated degree courses. It can be promoted and increased when they experience that their peers, professors, family, and friends believe in their engineering abilities and genuinely want them to be part of the engineering community.

Introduction

It has been observed that drop out of women engineering students, rather than being a result of a lack of intellectual ability is dictated fundamentally by the discouraging climates found in the various departments, courses, and schools of engineering. For these women, contributing factors such as lack of practical experience, an alienating atmosphere, and weak to non-existent, non-specific faculty support play the decisive role in their decisions to leave, all of which is highlighted by European and North American research such as Adelman 1998, Crawford/MacLeod 1990, Engler 1999, Goodman et al. 2002, Heublein 2000, Lewin 1995, Lewin et al. 1995, Minks 2000, Robst/Keil/Russo 1998, Rayman/Brett 1995, Sandler/Hall 1984, or Seymour/Hewitt 1997.

In the last 30 years, all over the world a variety of initiatives have been set up to involve more women in the study of engineering. Earlier attempts focused primarily on young women and making them more informed (Diegelmann 1995, Gaudard 1975, Heinzerling 1990, Kucklich 1996, Wächter 1999). Subsequently, stronger emphasis has been put on changing and improving degree courses and the cultures of engineering institutions (Bennett 1996, Copeland 1995, Godfrey 1995, hering/Nöller 1996, Kahlert/Mischau 2000, Lewis/Copeland 1999, Wächter 2004). It is in this context that the WomEng project (www.womeng.net) is situated. The main question of work package 3 for the Higher Education sector was: "Once women have enrolled in engineering degree courses what factors affect their decisions to either persist or drop out." (Thaler 2005)

To investigate those issues, quantitative and qualitative methods have been applied. The results presented in the following are based on questionnaire results of 699 engineering students (335 females, 364 males) and 637 non-engineering students (355 females, 282 males) in seven European countries (Austria, Finland, France, Germany, Greece, Slovakia, United Kingdom). Qualitative Sources comprise interviews with students who study engineering (in Austria, Finland, France, Germany, Slovakia, UK), who quit, changed subject or could have but did not take up engineering, like the French example, (in Austria, Finland, France, Germany, Slovakia) as well as interviews with representatives of the University Steering Committee who are in charge of curriculum development (in Austria, France, Germany, Slovakia, UK), male and female faculty (in Austria, France, Germany, Slovakia, UK), and Equal Opportunity Officers (in Austria, France, Germany, Slovakia, UK).

Key Results

Drop out

Generally, within the seven countries covered in this study, there is no specific data available. Drop out data is not gathered, not monitored, not evaluated. Some interview partners state that they think data is collected but they do not know where and what the exact figures are. Guessings vary between a range as far as between 10 to 60 percent.

According to our research, one third of the engineering students have thought about dropping out at least once. Apart from Finland, female engineering students think more often about it than their male colleagues. 70.1% of the students know of at least one colleague who dropped out of an engineering degree course.

The most difficult phase of a study is the entrance. Among other factors, students have to organise themselves, learn how to learn and handle the new freedom. Most of the drop outs happen in the first two years. The subjects in this time, though basic and important, are very "dry", as one interviewed expert put it.

Reasons for Dropping out

More than 10% of all engineering students of both genders questioned thought of dropping out because of the heavy workload, the different course expectations, or exam failures, and because of considering to change to another course.

The heavy workload dominates in Austria, whereas it is the course change in Finland. In France and in Great Britain it has more to do with the different expectations about the degree course, and in Germany and Slovakia most drop out thoughts are connected to poor exam performance.

More than three quarters of the students of both genders think that poor exam performances are the main reason for dropping out of an engineering degree course. More than two thirds also say that different expectations about the course and the heavy workload are further reasons for drop out. A little less than two thirds of the students think that a dislike of the subject could be a reason and more than one half believe that students who dropped out from engineering had changed into another course.

More females say that the dislike of the subject is very often a reason to drop out of an engineering degree course. On the other hand fewer females than males think that the heavy workload is a reason. The change to another course is slightly more often mentioned by females. The main difference to the female perspective is that males agree more with the heavy workload but not so much with the different expectations as main reasons for dropping out.

Austria has a high percentage of agreement with the statement "I did not feel comfortable", followed by the German sample. In France this statement has no agreement at all. The feeling of isolation is also a bigger drop out reason in Austria, again followed by Germany, than in other countries. On the other hand the "low number of female students and teachers" is a relatively bigger reason in Great Britain to think about drop out than in the other countries.

Self Description and Drop out Thoughts

More than two thirds of all students see themselves as co-operative, logical, caring, and clever. Three quarters of the engineering students agree with co-operative and logical. Three quarters of the non-engineering students agree with caring and co-operative. All female students describe themselves to be more co-operative and caring. Males see themselves more as logical and rational. Nevertheless more than two thirds of the male students, as well, say that they are caring. Generally the self-images of the students fit to the image that others have of them. Male students are considered to be more competent in engineering relevant tasks, while females are regarded as harder working and more socially competent.

A look at the correlations between self description and thinking about dropping out shows some interesting country and gender differences. No drop out thoughts occur among

- Austrian female engineering students who describe themselves as rational and analytical and believe in their leadership qualities;
- Austrian male engineering students who see themselves as only a little or not co-operative;
- Finish female engineering students who describe themselves as team players;
- Finish male engineering students who see themselves as creative;
- French female engineering students who describe themselves as machine oriented;
- French male engineering students who see themselves as clever and logical and have a high degree of self-confidence;
- Greek female engineering students who describe themselves as determined, rational and competitive;
- Greek male engineering students who see themselves as intuitive and risk taking;
- Slovak female engineering students who describe themselves as very co-operative;

- British female engineering students who describe themselves as very ambitious, very logical, very analytical, and very determined;
- British male engineering students who see themselves as very rational, very co-operative and very hardworking.

In Germany, there are no significant correlations between self descriptions, gender, and drop out thoughts.

Knock out Exams

More than a quarter of the students report knock out exams. About 60% of the students think that knock out exams lead to drop out. Almost 60% say passing knock out exams increases their self-confidence. But only 15.6% females and 26.3% males feel comfortable with those exams.

Gender Differences

Generally, interview partners say that fewer women drop out than men. That could be true considering their assessments of the motivation of female students to study. It could also be a biased conception. Since no data exists this is difficult to evaluate.

Interviewed experts and students, in general, say that there are no gender specific differences for dropping out. However, one gender difference mentioned in the expert interviews by both faculty and students is that female engineering students always have to justify their degree choice as it is perceived as not normal for a woman to study engineering. This can subsequently lead to a decrease in self-confidence. Students report that they have to justify their decision, that they have to perform better, that they constantly have to prove technical competencies. Often they are also addressed as "the secretary".

And they are confronted with subtle but persistent discrimination in the form of jokes, remarks, different exam standards. Some students also report discrimination through wrongly understood politeness, for example some professors give women easier exam questions and better grades. But this is not what female students want and it does not help them at all.

Sexist jokes and remarks were mentioned by Austrian and Slovak students.

Women engineering students require their needs be given equal consideration to those of the men. They are very sensitive towards women promotions because they think that could be seen as a privilege. Females need to be treated unbiasedly and to not always have their engineering competencies unduly questioned. Female students often are treated as if they can have no technical competencies. Problems of women are treated as individual problems, they are not seen as gender problems. Gender fair language is not used and is made fun of. Women have to get used to common male dominated language. But if someone is talking to them as an individual they want to hear terms that refer to them as females.

Coping Strategies

The most often mentioned coping strategy is talking problems over with friends or family members, or with colleagues. Only a few students consult counselling services offered by the university or student organization/union and seek professional advice.

Non-persistent students often reported that they did not talk about their problems with others but were brooding and tried to settle their inner conflicts by themselves. Doubts remain unspoken, partly because of fear of giving the impression of, or actually being a failure.

To turn to advisors or talk to professors seems to be more common in France. Communication with professors appears to be particularly difficult in Slovakia. Several students talk about not being treated like adults and not liking the demeaning behaviour of their university teachers.

The support from the department, including the secretaries, is very important for the students. Measures should aim at increasing communication, and stimulating and supporting bonding between staff and students.

Austrian experts mention several times that dropping out should not be seen as something negative, as a failure, but as a re-orientation that helps students finding a better solution for their careers.

Supportive People

While more than half of the engineering students agree that their parents were encouraging for their pursuit of an engineering career, only about one third of the non-engineering students see their parents as encouraging for the choice of their degree course.

The most important supporting persons for engineering students are friends and family, colleagues, room mates in dormitories, and members of the department. Study groups and tutorials are very important as well.

The support of family and peer group is vital for the pursuit of an engineering career. Females think that both parents are influencing them nearly the same way and males think that the influence of their father is larger. Role models are equally important for both sexes. Teachers have a stronger influence on women than on men.

Supportive Factors

More than two thirds of the students agree that interest in the subject matter in engineering, salary potential and employment opportunities were the most encouraging factors for their pursuit of an engineering career. Salary potential and employment opportunities are more important for male students than for females.

Self-confidence

More than two thirds of all students think that their ability to think analytically and critically and their communication skills increased during their studies. Two thirds of the engineering students say that they also improved their engineering and team working abilities, while more than one half of the non-engineering students say that their team working skills are better now.

Atmosphere

The atmosphere of the engineering department has a relatively high importance to all students (40.3%), but the importance is for females higher than for males (46.3% vs. 34.9%). The atmosphere of engineering courses is a more encouraging factor for females (41.9%) than for males (37.1%).

A little less than one half agrees that they have a healthy combination of private and studying life and the atmosphere at their department is supportive for their individual development and their personal concerns are valued. About one half of the engineering students describe the atmosphere in their degree course as a healthy atmosphere of telling stories and jokes.

More than half of the students want more co-operation in their department atmosphere. 40.1% of the males and 46.2% of the females want more personal concern too. More than half of the males but only one third of the female engineering students want more women students. More than one third of the engineering students (more females than males) want more women staff.

An interesting result is that the number of women in the major and the number of the women faculty are more discouraging for males (42.9% and 46.6%) than for females (29.0% and 34.7%). A little more females think that competition in engineering classes is discouraging (39.5%) than males (33.5%).

Infrastructure

Most students feel comfortable with using computer facilities, the library, and laboratory equipment. Females feel a little more comfortable with the workplace than males and equally comfortable with the workload. However, there is a big gender difference in using workshop equipment (41.4% females, 52.6% males) and asking questions in class (34.6% females, 45.4% males).

Interdisciplinarity

More than one third of the engineering students want to have more non-engineering subjects. There is only a slight gender difference. 34.6% of the male and 37.9% of the female engineering students want more interdisciplinarity in their degree courses. What is interesting is that more than one quarter of the non-engineering students say that they would have chosen an engineering degree course if more subjects from human and social sciences were included.

Austrian students (58.2%) want non-engineering subjects more than the other European engineering students (average number for seven countries = 36.3%). More Austrian females (64.7%) like to have non-engineering subjects than the Austrian males (53.3%), but most males also want to have more of them too. And the gender difference is not as big as in other countries (for instance Finland, where 35.0% females but only 16.7% male students want more non-engineering subjects). One explanation could be that the need for more interdisciplinarity is so big in Austria that the country difference is much higher than the gender difference. French students also say that more subjects from human and social sciences would have influenced their decision to study engineering (38.9%), with a huge difference between males (28.2%) and females (47.5%). Consequently, more human and social sciences in engineering studies will attract more women.

Recommendations

Students who experience a positive atmosphere in their department and classrooms are more likely to stay in engineering. Social enrichment activities like guest lectures, field trips, social events can contribute to that. In addition to these social opportunities further support measures like mentoring, tutoring, skills workshops, career explorations are particularly crucial during the early years at university. Academic advisors, fewer required “grunt” courses in the first two years and more room to pursue interest outside of

engineering are other recommended measures. Networking and study groups can help to counteract the isolation that women in engineering may experience due to their minority status.

Internal Study

Cultures and history of universities differ not only between countries but also within countries. Therefore it is highly recommended to look at institutions specifically to develop particular measures. See, for example the successful program to retain female students in computer science at Carnegie Mellon (see Lenore Blum: "Transforming the Culture of Computing at Carnegie Mellon": http://www-2.cs.cmu.edu/~lblum/PAPERS/TransformingTheCulture.pdf; Lenore Blum: "Women in Computer Science: The Carnegie Mellon Experience": http://www-2.cs.cmu.edu/~lblum/PAPERS/women_in_computer_science.pdf).

Statistical Data

So far, data about dropping out is not gathered, not monitored, not evaluated. To have a firm basis for university planning, it is vital to have access to statistical gender aggregated data.

Exit Interviews / Questionnaires

To learn more about the motivation and reasons of students who quit a degree course or change to another subject, exit interviews or questionnaires should be institutionalized.

Curriculum Reform

Approximately 50% of all students, male or female, drop out in the first two years. Subjects in the first two years are basic and dry. The problem is not a female one. A reformed curriculum, including some project oriented seminars where students get an impression what it would be like to work as an engineer, could influence the drop out rates. There is, however, a conflict since some universities like the drop outs because they do not want such a high number of students and in many minds there is still the idea prevalent that only those who survive the dry basic subjects have the right to persist.

More Interdisciplinarity

Curricula do not fit the requests of work life reality and therefore engineers can lack certain social competencies also required in the profession. The myth that engineering is so complicated leads to the wrong idea that it must be taught purely and without other disciplines – so that graduates become "real engineers". But interdisciplinary degree courses have supportive aspects for students and reflect real work life situations. Existing curricula must be evaluated.

Shorter Study Duration

Austrian experts consider the long study duration a major cause for the high drop out rates. To reduce the long duration of studies is perceived as an important issue. Thus, the introduction of the Baccalaureate is by some experts seen as a measure to reduce the drop out rate. A short study offers the students a closer aim and helps them to get better orientation and overview.

"Common Year"

Reducing the duration of study and the introduction of a "Common Year" for all first year students of all degree course may decrease the drop out rates. It works successfully at the University of Mining in Leoben, Austria. The "Common Year" is a guided first year where all students learn the basics together, learn how to organize themselves, learn how to prepare themselves for exams and after one year they can decide which degree course they choose. This approach could better inform the students and their decisions.

"Catch up" Courses

"Catch up" courses for students with different or insufficient levels of knowledge from high school should be offered for male and female students. These additional knowledge requirements should be made available to all high school graduates. But they must be a voluntary offer for students who think they lack something.

More Group and Project Work

Group and project work is appreciated by both male and female students. However, it is much more work for lecturers and students.

Improve Didactic Skills of Faculty

Professors and assistants need pedagogical competencies. Professors and assistants should learn about adult education and gender before they teach students.

Gender Sensitivity and Gender Mainstreaming Training for Students and Staff

Gender equality should be an interdisciplinary topic for every degree course. It should give at least one lesson in the beginner tutorials, where the issue can be discussed. Gender trainings should also be obligatory for every professor and assistant at the university. Gender fair language should be a standard (in every paper, on each web site, and especially in the courses) for an institution which always claims to want more females.

Contact Persons

Gender sensitized contact persons should be available at a low threshold level, so that students are encouraged to talk to somebody they can trust. This aims at increasing the number of students who seek advice and accept counselling as an enriching and supporting service.

Social Counselling Service

The University of Stralsund, Germany, for example, offers a social counselling service, especially students who are afraid of exams find help there. Many female students are fraught by this kind of anxiety.

Install "Communication Zones"

"Communication Zones" help to increase interaction with faculty and encourage more personal talks. Support from the department, including its secretaries, is very important for the students. Therefore, measures should aim at increasing communication, and stimulating and supporting bonding between staff and students. A Technical University is a place where people should get in contact and communicate with others, there should be room for that purpose.

Entry Events to lower the "Cultural Shock" in the First Semester and More Tutorials

In these courses students get introduced to the university, to the buildings, infrastructure, how to learn, how to organize the study, what they can expect from their study. This strategy does not help to avoid drop out but it helps students to find out at an early stage if this degree course is suitable for them and if it will meet their expectations. Students will realize faster if they have chosen the wrong degree course. Tutorials for beginners are helpful but they also need to be enriched with gender issues.

Mentoring for Female Students as well as for Female Faculty

Mentoring is very important for female students. They can get advice, learn to avoid the usual troubles, learn from faults of others.

More Accompanying Measures

Accompanying measures, like guest lectures, field trips, career explorations, skills workshops, are helpful

for female students during semester time, to better keep in touch better with their demands and needs and to avoid dropping out or changing of degree courses. Such measures are extremely important especially during the first months.

Role Models and more Female Staff in Engineering Subjects

It is vitally important to make women engineers visible. Hiring more female staff, especially in engineering subjects, is strongly recommended. Young women should see that being a women goes well with being an engineer. Furthermore they need more information about what contains an engineering degree, which jobs they can get afterwards and how the career prospects look like. Using gender-sensitive language avoids the situation of giving some female students the feeling that they are not welcome. Positive role models play an important role in challenging prejudices like "Women cannot be engineers."

Present a Different, more Appropriate Image of Engineering

Technology counts as destroyer of the environment. An engineer is a rational, analytical, problem-oriented person. Engineers are not supposed to be creative. Stereotypical assumptions perceive engineers as competent, qualified, having a lot of experience, being field-oriented, and earning a lot of money. There are a lot of prejudices against female engineers, they are not expected to be good engineers. Role models are missing, a female engineer is always an attraction. Female engineers are watched more critically therefore one sees more mistakes. There is a prejudice that engineers are interested only in technology. The image of technology is hard. Women are responsible for the soft things. To counteract these stereotypes and to present appropriate images and information, women and men actually working as engineers should meet young students and explain to them what they do. It is very important to have women and men doing that. A television serial which would show women scientists or engineers could also give insights in what engineers do and help changing women's image in the general public.

Better Information

To decrease the drop out rate more information about the degree course and the professions, more engagement and open house days are necessary. Technical Universities and high schools should co-operate more closely and better inform their students what additional knowledge could be useful for their further education. More easily accessible, readable, and complete information about the degree courses as well as about other aspects of studying engineering (such as study groups, counselling services, networks, internships, studying abroad, etc.) addressed to all high schools. This would make students' choices easier and they would know better what to expect from university studies (content, extent, form, and requirements).

Conclusion

A detailed country-specific analysis of European data is very important. European engineering education has many potentials (and needs) for improvement. Stumbling blocks and factors of success differ in the various European countries, but they also differ for female and male engineering students.

It is vital for women to feel part of a larger engineering community. A sense of belonging is strongly linked to a student's self-confidence, especially for female students in a minority and in male dominated degree courses. It can be promoted and increased when they experience that their peers, professors, family, and friends believe in their engineering abilities and genuinely want them to be part of the engineering community.

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Who or what creates a successful study environment? – How female engineering students in Europe assess their study situation.

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Abstract

The paper is closely related to the results of the European project WomEng (11.2002-10.2005) which aims to investigate the under representation of women in engineering education and professional life in seven involved countries (Germany, France, Austria, Great-Britain, Finland, Slovakia and Greece). Through an extensive quantitative questionnaire and qualitative interviews in completion a presentation on the situation of female students in engineering degree courses in the above-mentioned countries is possible. For this paper work package 4 related results on organisational cultures at engineering departments and degree courses will be analysed. The following questions will be answered:

- *How do female engineering students describe their current study atmosphere? What or who creates in their eyes a satisfying study environment?*
- *How do women assess their current situation studying in a field, which is European wide still male dominated? Do they feel marginalised?*
- *How do the young women cope with their "exotic status"? Do they appreciate, dislike or even not recognize it?*

The difference of those perceptions in comparison to male engineering students will be partly presented too. As conclusion factors hindering and supporting women engineering students progression at university will be shown.

1 State of Art

It's not women's deficit in abstract thinking, etc. what drives them away from technology, but content and climate in technical institutions, referred to as atmosphere of 'dominant masculinity' (Sagebiel/Dahmen 2005 with reference to McLean et al. 1996, Connell 1999).

The ETAN report points out, that in all EU Member States women are under-represented in mathematics, computer science, engineering and architecture (except Germany). Girls seem to prefer sciences linked to nature, human and social matters (ETAN 2000, p.58). The results from the former European project CuWaT (1998) show that cross-disciplinary courses and significant elements of group work and project work are effective for retaining women in engineering.

From the US research it is known, that the low number of females in engineering can be explained mostly by the lack of self-confidence in intellectual abilities based on low self-esteem due to the female students' minority status and their feelings of isolation. Moreover men are less affected by poor teaching, poor organisation of the course material and by a dull course content. Etzkowitz et al. 'have found that "critical mass" is meaningless when women are isolated and unknown to each other, when affiliation with other

women is too stigmatising, or the available female faculty model reflects an archaic male stereotype, impossible to emulate or incorporate into a contemporary professional identity' (Etzkowitz. 2000, p. 245).

Australian research stresses the significance of women working with men and of gaining sympathetic men as partners for social changing process in engineering education (McLean et al. 1996).

2 Methodologies

Quantitative and qualitative methods have been used in WomEng in all partner countries and for all project work packages. In each project involved country characteristic institutions of higher education were chosen for investigation and included in the sampling. By questionnaire 100 female and male engineering students in each country were asked about their study background, study experiences etc. For comparison a group of 100 students out of different non-engineering majors like social sciences, humanities and economics were asked about their opinion and experiences too. In completion several qualitative methods were developed to understand more complex and deeply institutional barriers for women engineering students. Faculty interviews with representatives for degree courses, expert interviews with members of steering committee and officials from equal opportunity office have been done. The perspectives and views of students came in from individual interviews with persistent and non-persistent students and especially from separate focus groups with female and male engineering students. 3 Results on women in a male dominated study environment.

3.1 First steps and hurdles as a student

Transition from school to university was partly not so easy for the interviewed female students. Especially problems with orientation and self-organisation at the beginning of study were named often. Additionally the experience that learning at school does not have much in common with studying and learning at a university can lead to uncertainty of the fresher's. So, learning how to learn is necessary. Here a mentoring system can help, which starts already at the beginning of the study, or buddies/tutors who support the fresher during their first weeks and months at the department. Valuable insider information can be shared and imparted, and in completion feelings of isolation and loneliness can be reduced. Integration of new students can be seen as a prominent factor for avoiding drop-out.

As a first icebreaker welcoming events at the start of study could work. The importance of those offers is estimated as high by almost all countries and students. That first contacts to other students were made, was the most applicable answer possibility which was agreed on. In UK the teachers seem to be more involved during the welcome events than in the other countries, students say with 73,6% that they made their first contacts with teachers on welcome events. In Slovakia more than 50% of the students also agreed on this item whereas in the other countries the numbers were much lower. A depending factor here fore might be whether the welcome events are organised by the dean/faculty or by student representatives/student body.

3.2 Interdisciplinary curricula and teaching methods – what are the demands of women students?

Austrian female students would appreciating more interdisciplinary subjects with 64,7%, followed by Greek women with 59%, in contrast to France where obviously the curricula already included non-technical issues in a higher amount. The higher amount of non of technical curricula is one important

factor for enhancing the attractiveness of engineering degree courses especially for women.1 Looking for possible changes most of the faculty thinks that interdisciplinary subjects can not be included into the engineering curricula because otherwise indispensable technical subjects would have been cut.

Asked what kind of non-technical subjects students would like to be added to their current curriculum, languages with over 50,0% agreement in all countries was the most favoured subject, second soft skills. For both subjects as job requirements the connection and value for later professional life might be already clear for the students. Especially in France 77,5% of the women would like to learn more soft skills, followed by the Austrian (67,6%), German (57,4%) and Slovak (55,3%) engineering students.

But also interesting seems the fact that more than half of the Scottish and Greek respondents would like to have more technical subjects in their curriculum and also the Slovak students agreed with 41,7% on this item, followed by Finland with 31,6% agreement. In Germany, Austria and France this option is not appreciated.

In evaluating teaching methods all female students ask for more dialogue, more discussion, and more projects, less lectures which are not appreciated and are presented 'boring" and without enough practical links. An interesting result out of the questionnaires is the overall high agreement towards all kinds of practical work, e.g. industrial placements, except for Austrian female students. The linkage possibility to use theoretical knowledge already during study time seems to be an important factor for the women.

So called knock-out exams or weed out systems exist above all in Germany (72,0%) and Slovakia (40,0%). These exams are a big topic during the first cycle, they lead to insecurity and doubt before but passing them increases self-confidence as Slovak women agreed with 63,1% and the German ones with 82,0%.

3.3 Atmosphere descriptions: healthy combination versus competition

By questionnaire female students were asked how they would describe the atmosphere at their degree courses (multiple answer possibilities). The main conformity in most of the countries got the item "a healthy combination of private and studying life". The "importance to spend leisure time together" as atmosphere describing indicator should not be underestimated because also most of the female students agreed that they spend leisure time with their fellow students ratings from 43,8% (Austria) to 69,4% (France), in Germany only 32,0% agreed. An study environment where "personal concern is valued" is true for French, English, Austrian and Slovak students. German and English women in engineering study also in an "atmosphere with a healthy combination of telling jokes and stories" and Austrian students think they experience an "individual supportive atmosphere".

Predominately competitive and masculine climate in engineering degree courses is one deterring factor hindering women to pick up a technical degree course. Greek female students agreed most on studying in a competitive atmosphere (50,0%), followed by UK (38,0%) and Slovak female students (25%), while it seems to be no problem in all other partner countries. For coping with this competitive male behaviour 'some women adopt the competitive imperative, and learn how to compete in male terms. Men are often not comfortable with this. It is their game, and there is no place in their prestige system for a woman who competes successfully with them'. (Etzkowitz 2000, p.55). Some women stated they got the impression to

[1] The European project INDECS, being preliminary to WomEng, proved the attractiveness and acceptability of interdisciplinary degree courses on data basis of a one-year explanatory research. For further information please look at www.indecs.uni-wuppertal.de

study in an atmosphere where no mistakes are allowed, no wonder that female students feel less happy asking questions in a class in comparison to their male fellows. And one fifth of the women experienced, that the instructors made women demeaning comments in their engineering lectures, which supported that uncomfortable feelings. In Greece 15,6% of the women feel that they study in a atmosphere of telling jokes and stories with the intention to exclude women (10,5% France, 10,0% UK).

3.4 To study in a male domain – how does it feel?

First of all the asked women are confident that engineering is the right major for them, but the agreement differs e.g. from 80,0% in Germany to 49,0% in France. In total 32,9% of the females thought once about dropping out of their engineering major. Most prominent reasons for breaking up studies are "poor exam performance" with 80,7%, the experience that "the course was different than expected" (74,7%) and the "dislike of subjects" with 69,7%. And also women are satisfied with their current studies overall (Germany 76,0%, UK 72,0%, Austria 69,7%, Slovakia 65,3%, France 58,9% and Greece 52,7%).

3.4.1 High visibility is not always an advantage

After entering a degree course where the majority of students and faculty members is male, many women face problems which they possibly never have thought about before: "for first time in their lives, white women suddenly experience what it is like to be a minority, negatively viewed by the majority" (Etzkowitz 2000, p.60). And also Sonnert says "Women taking science courses may encounter a classroom atmosphere in which they face varying degrees of neglect or outright hostility from both their co-students and the faculty" (2000, p.40).

Especially the high visibility of women studying in a male domain does not always lead to feelings of comfortableness, although women are conscious about their minority situation. Female students often feel observed because of their visibility as women in a male domain and they feel to be more critically watched than their male fellows. On the other side faculty opinions show that female students who retain in engineering degree courses perform often better than their male colleagues. Different explanations could be the reasons: by the above mentioned higher attention as minority in engineering could lead to pressure or is it simply stronger commitment towards thought material of the women? The third explanation could be a kind of elitist factor: Women who decide entering a technical or engineering major often do this with better school graduation marks than boys, because it's still not 'normal' to study these subjects for women, so themselves assume best marks in maths or physics are necessary while boys don't questioning that.

Qualitative results show that the female students are conscious about their minority situation, and take sometimes advantage of it. So they play with gender prejudices like e.g. presenting themselves like little technical fools for explaining some problems which occurred and some of them enjoy their 'princess-status'. But some interviewed women see their higher attention conflicting like this quote shows: "Maybe some professors have smaller expectation in the knowledge of the women and so they invest more time in explaining something to them. So maybe it is not only positive for women to be preferred treated?".

3.4.2 Self-comparison with male fellow students underestimation or reality?

The self-assessment of the female students in comparison to their male colleagues reflects partly the known phenomena of the underestimation of the own performances of women/girls like shown in the quantitative results. Especially the women from UK think with 48,1% that they have to spend more time

and effort on the class work than the males do, followed by Finish (46,3%), Slovak (42,9%) and German (38,8%) students. Here the lowest numbers come from the Greek women with 14,3%. But maybe this item can also be positively interpreted, that women are more thorough in studying and that's why they think they spend more time on the mentioned issues than the males? And also half of the German and Slovak women think they are more committed to engineering than their male fellows.

Slovak women seem to have a high self-confidence concerning their abilities as they gave the highest agreement to the following statements: they think with 44,9% that they are better in solving engineering problems than their male fellow students and also they are the ones who say with 38,7% that they understand engineering concepts better. And for 43,7% it's clear that they have more confidence in their engineering abilities than their male colleagues. But on contrary in Slovakia one fifth of the women students thinks that engineering suits men better than women!

Again the Slovak women say with 43,7% that they understand the engineering concepts better than the males. So overall the Slovak female engineering students seem to have a more self-assured opinion about their engineering abilities than women in other countries.

Nearly 60,0% of German female engineering students have the opinion that they work better with other people, followed by UK with 43,7%, Slovakia 42,8% and Austria 40,0%. The high agreement towards this item in nearly all project countries, reflects the gender specific prejudice of the social women which is also self-attributed by them.

3.5 Changes which would be appreciated by women students

Totally 33,4% of the women students would appreciate more female fellows in their classes. Austrian female students show the highest agreement with over 50% that their at departments should be more women students and also 60,6% of them want to have more female faculty members at their degree courses. More women staff is totally wanted by 41,6% of the female students; this high appreciation of female teachers and lecturers could be a link towards missing role models for the young women. Obviously there seems to exist a demand on appreciating more females in their courses although they are not complaining about their current situation as minority group.

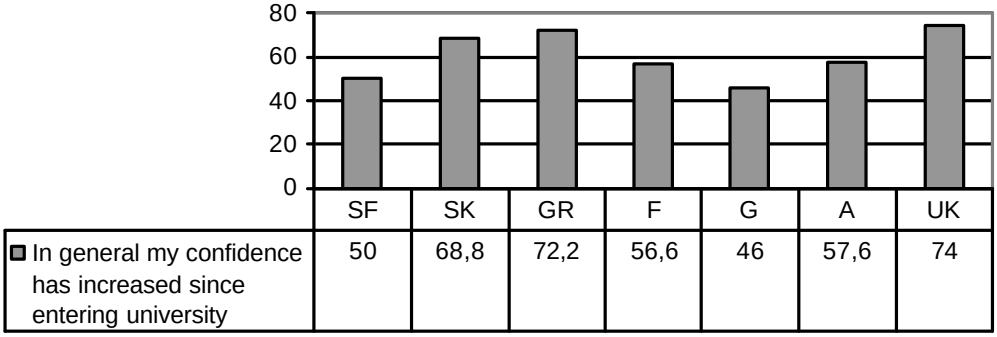
Slovak women like to have a more equal interaction structure between male and female students (35,5%), this result would prove the results out of interviews that female students in Slovakia are sometimes confronted with discriminating statements.

3.6 Preconditioned self-confidence as a matter of course?

A high amount of self-confidence was seen by most of the interviewed faculty members as important factor for being successful as female student in a male dominated degree course. An Austrian female lecturer said, that young women in engineering need a high self-confidence in their competencies and in addition family support and self-esteem because "sometimes they have to defend themselves". And a female lecturer in civil engineering points it out more critical: "a good base of self-confidence is a necessity for women right from the beginning of study. Otherwise it has no sense to pick up an engineering degree course!". But looking at quantitative results of all countries female students assess their self-confidence as increased since the beginning of study, this means looking back at the start of their university life half up to three quarters would rate their confidence lower than today (see picture 1). Also a six year longitudinal study at the university of Washington showed that increased of self-confidence continued at the end of

the junior year which goes along with feelings of acceptation into a department" (Brainard, Carlin 2000, p.32).

Table 1: Self-assessment concerning confidence – answers of female engineering students



	SF	SK	GR	F	G	A	UK
In general my confidence has increased since entering university	50	68,8	72,2	56,6	46	57,6	74

3.6.1 Single sex degree courses as way out?

One of the main reason for implementing single sex engineering degree courses is to build and further this self-confidence in technical abilities, which promoters of co-educative engineering degree courses see as a precondition. Today in Germany several engineering single-sex degree courses are implemented especially at universities of applied sciences. The study atmosphere of women only should allow a prejudice free study time without male competition structures. Through this offer also young women should be attracted who would have been deterred by co-educative degree courses.

Members of the investigated single sex degree course in Stralsund/Germany stated the opinion 'single sex teaching increases self-esteem and self-confidence' of female students. At the same time the model can be a change agent, as it shows that a traditional department culture of mechanical engineering could be changed. Old structures were over thought and more and more given up.

3.6.2 Single sex teaching – a critical discussion…

The WomEng consortium discussed critically about the necessity of mono-educational study possibilities in engineering for women.

For most of the interviewees, independent if they were faculty members or students, single sex degree courses and teaching still has the bad 'flavour' of needing special support or the imputation that females are not able to study engineering in a company with men. The vehement aversion of female students in interviews and focus groups allows concluding, that women do not want to have a special status and are afraid to be marked off. This might go along with observations Etzkowitz and his team made regarding special women offers at departments „many had no programs for women students and if they did, fear of stigma around joining was high" (Etzkowitz 2000, p.179). Opponents of mono-education, faculty and students, think 'that is an artificial world' and that women who want to study engineering must have self-confidence right from the beginning, otherwise they would not succeed. Women working together would be more uninhibited, could develop ideas more easily and deepen their knowledge without competing with the men.

The results regarding single sex teaching out of the questionnaire show most disclaiming attitudes towards this teaching method. Astonishing is the high number of Slovak women who agreed on the item 'female students would feel more relaxed without male students' with 77,1%. For the whole question a high number of 'I don't know answers' is obvious, so for the students it was hard to judge or imagine what changes single sex classes/degree courses would offer, here it becomes clear that information is necessary to dispense single sex teaching from prejudices.

4 Factors supporting women engineering students progression at university

Recommendations towards a warmer climate for women students (not only in engineering) were already provided by Hall and Sandler in 1982. Among the negative behaviors for teachers to avoid are: making seemingly helpful comments that imply women are not as competent as men; disparaging women in general, women's intellectual abilities, or women's professional potential; and, using sexist humor as a classroom device.The following factors developed out of WomEng research show which aspects could support the creation of women friendly engineering degree courses, but they should not be seen detached from one anther. Only the combination of single measures can lead to a study environment which is also supportive for women.

4.1 Chances of recruitment programs and school co-operation

Close school and university cooperation's offer multiple chances. First especially girls who might have some kind of 'fear' or 'insecurity' to get in touch with techniques can diminish this through practical exercises which offer e.g. summer schools or summer universities. Additionally these offers can contribute towards a changing of the image of engineering which is according to the asked female students:

- „not a nice one!" and
- „a male one!" and
- „a crude one!" and
- „a poor communicating one!"

This engineering image leads to a conflict for the young women as their understanding of femininity does not fit into this masculine picture.

As two last advantages a higher visibility of (female) role models is raised which can contribute towards image change too and the young women can gather information about engineering work-life/study, so the information lack can be reduced.

4.2 Integration

Universities should pay more attention at students in the first years to help them coping with the change from school to university, it's important to create an atmosphere where new students (independent of their gender) feel welcomed. Especially welcome initiatives can provide important ice-breakers at the start of study, students can be encouraged to get to know others on the course and faculty members.

The integration in the department community could be supported by mentoring or buddies schemes, which seem to develop a second supporting factor: being a part of the community.

4.3 Mentoring

Mentoring initiatives seem to be a good innovation but are not known enough so people are sceptically about their success. The implementation of such schemes help to reduce problems of orientation and organisation the beginning. Additionally the introduction of such programmes could be a suitable method to reduce the drop out rates during the first part of study.

Industry mentoring is helpful for the women because they can get close contact to professional sphere and at the same time it provides a more realistic impression from engineering job life.

4.5 Curricula and Teaching Methods

Students stress the importance of training soft skills during their study, they also ask for more classes based on a dialogue, on exchange, on direct contact with other students and teachers. Project-oriented and practical work can help to link theoretical knowledge with practical application. The early introduction of group work can also assist to integrate new students and to build up something like a community.As conclusion curricula should be thought over regarding a higher amount of practice, in combination with interdisciplinarity.

4.6 Equal treatment

Female students often feel observed because of their visibility as women. So they are more critically watched and have to be better and work more. Female students have to perform better to be accepted or are underestimated by the teaching staff. The female students still have to overcome with male perception/attitudes to engineers in society. Inappropriate behaviour from some teachers and/or male culture at engineering faculties causes uneasy feelings. The use of gender neutral language can be a supporting factor too.

Women do not want to be 'present women as being something special'. It would be better to present women as being something normal in engineering. As female students stress that they want to be treated equally, there is a huge need for further education and training, for gender sensitivity programmes for both lecturers and students. Only then can the awareness be spread that equal treatment in an unequal environment does not lead to equality and equal opportunities.

More information has to be distributed among the female and male faculty staff about the contents, methods, aims and intentions of mentoring and of single-sex education.

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Reflections on Women, Civil Engineering and the UK Construction Industry

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Abstract

I have worked within an inter-disciplinary team of academics on the topic of equal opportunities for women and men in civil engineering and the construction industry for twelve years. This work has been supported by several research grants, and the financial and practical involvement of some major UK contractors.

I begin this paper by reflecting on this work, drawing out the principal issues that affect women as they respond to the challenge of working within this industry, and presenting the issues in the form of a typology. The paper continues by presenting some findings from one of my major research projects where 46 matched pairs of women and men civil engineers and construction professionals were interviewed. Certain key themes that emerged from the research, which go some way to explaining differential career progression rates between men and women and the poor retention of women to construction organisations, will be examined.

Introduction

The UK construction industry is quantitatively and hierarchically male dominated. This is highly significant given the impact of the built environment on society. In the UK several government initiatives have been introduced to encourage women to pursue careers in the engineering professions. While such programmes have succeeded in increasing the proportion of women studying engineering, there has not been an equivalent increase in engineering and construction professionals. This indicates that although women are attracted to a career in construction, the culture and structure of the workplace may deter them from pursuing their chosen profession.

Nancy Lane (1997), co-author of "The Rising Tide" report on women in science, engineering and technology (SET), commented, "*Engineering … is a subject where women are currently catastrophically underrepresente*". Studies have shown, however, that women are not driven away from technology because of lack of ability, but rather because of "an atmosphere of dominant masculinity" (Sagebiel 2003). This is despite research by the Scottish Higher Education Funding Council advising that female engineers are generally perceived to be better qualified and more highly motivated than their male counterparts (SHEFC 1997). Predominantly, a business case is put forward for increasing the number of women in the industry (Bagilhole 1997). The argument is that by failing to increase the number of women, the industry is under-utilising the full range of skills and talents in the population. In addition, a more gender-balanced

construction organisation should be able to increase their efficiency and effectiveness by projecting a more pluralistic self-image.

As a result of such arguments numerous initiatives have been employed in the UK to increase the numbers of women entering engineering education and employment. In 1984, for example, the Women into Science and Engineering (WISE) campaign was established, with the support of the Equal Opportunities Commission and Engineering Council. The publication of the Construction Industry Board (CIB 1996) report also raised equal opportunities to the top of the industry's performance improvement agenda, particularly in the light of the skills shortfalls forecast for the sector in the millennium (Dainty, Neale and Bagilhole 1999). Such initiatives have also had some success in increasing the number of women studying engineering. Glover (2000) reported that in 1973 only 3% of engineering and technology undergraduates were women. This is compared to 15% in 2003/04 (HESA, 2005), although figures vary widely by discipline. In fact the figure for civil engineering is slightly above average (17%), however, it is still significantly below the average across all subjects (56%) (ibid). Also, overall only 1.6% of all female students in higher education are based in engineering (ibid), reflecting that while the number of women studying engineering has increased, this is, in part, attributable to the rise in female students across all university disciplines. Furthermore, the increase in women engineering students has failed to translate to an equivalent increase in female engineering professionals, with suggestions that less than 10% of professional engineers are women (Fielding and Glover 1997). More recent estimates suggest that women only account for 6% of engineers and technologists in professional or associate professional and technical occupations (ONS 2000).

However, Equal Opportunities (EO) has been recognised as being able to make an essential contribution to construction industry development in the UK, and has therefore become an important research theme. A broad and high-profile review of the UK construction industry was conducted by Sir Michael Latham MP, and publicised widely (Latham 1994). This led to the formation of a Construction Industry Council (CIC), with twelve working groups to steer the practical implementation of Latham's conclusions, one of which (Working Group 8) dealt exclusively with EO. We were awarded the contract to provide research and administrative support to this Working Group, which gave us a good insight into how difficult it is to formulate a clear implementation strategy within such a diverse industry.

The Working Group focused almost exclusively on gender and the report that emerged (CIB 1996) gives very up-beat arguments for increasing women's participation in the industry, which our research findings cause us to view with some scepticism. Nevertheless, the report acknowledges the importance of EO for the development of the industry, makes a valuable contribution to the advancement of women in the industry, and contains some practical advice, such as a code of good practice that we formulated with the advice of senior personnel managers in the industry.

In this introduction I wish to give a brief review of our work on EO in the construction industry, and some of the important factors that have emerged. As this research proceeded, we developed a typology to describe the principal factors that effect women civil engineers' working lives within the construction industry. This typology is presented in the first part of the paper. We also became directly involved with the construction industry. Firstly, we gained the direct support of a major construction company, which had adopted the visionary strategy of recruiting women as almost half their graduate intake, on the grounds that women's abilities as communicators and teamworkers were, generally, superior to those of men. With the support of the company, a successful application was made for funding from the UK

Economic and Social Science Research Council to look at "Improving Women Engineers' Careers in Large Construction Companies". The second part of this paper outlines our methodology, analytical tools and conclusions from this project. This research illustrates vividly how difficult it can be for women to work in this industry, to an extent that left us surprised and deeply concerned. The main conclusions seem to be that this is, generally, a difficult industry for women to work in, and that the women who do succeed do so by adopting male behaviour.

Typology of Issues Effecting Women Working in the UK Construction Industry

Table 1 comprises the typology of the principal issues in the UK construction industry, from both inside and outside the industry developed from our research. It shows the effects on women, the resulting implications for the industry, and puts forward possible remedial actions. The typology is structured on the four locations from which the issues emanate. It does not attempt to rank the issues in order of importance. The first row shows influences on women's achievement from outside of their working lives. The second row shows the influence of the general labour market outside the industry. Finally, the industry itself is considered, categorised into formal structural factors that have developed in the industry, and the informal (cultural) factors.

Table 1: Typology of the issues, implications and possible actions and remedies

Location of Issues	**Implications for Industry**	**PossibleAction/Remedy**
Outside Employment Pre-employment socialisation Education	Women are guided towards traditional careers, and do not fit into male-oriented work cultures. Male dominated industry and low retention of women workers	School programmes and marketing.
General Labour Market Image of the industry is strongly male, technology-stereotyped, and "tough". Pay and status of the industry is perceived as low.	Skills shortages, lack of competitiveness in the global market, a need for new blood.	Positive action to promote the industry and attract women
Formal Structural Factors within the Industry	Exclusion of women due to their	Formalise and standardise

Informal recruitment by personal contacts.	lack of contacts within the industry.	recruitment procedures to comply with EO legislation.
Working conditions are male-oriented. They conflict with women"s roles of wife and mother leading to work/family conflict.	Contributes to poor career progression for women.	Implement EO policies and action programme which includes working conditions which are suitable for women (e.g child care, job share, career breaks).
Work facilities not available for women, compulsory clothing includes a "male uniform".	Maintains an environment which is not encouraging to women, if not hostile.	Provide separate facilities and provide suitable clothing.
Industry structure	Dynamic, intense outdoor environment and anti-social hours can discourage women	Improve and adapt working practices and schedules where appropriate and possible
Informal Cultural Factors within the Industry		
Construction education	Leads to low numbers of young women entering the industry where educators act as "gate-keepers" through a hidden curriculum.	Monitor teaching staff and courses for gender issues.
Male-dominated industry sub-culture and organisational ethos.	Hostile attitudes, male orientation and lowretention of women.	Investigation into sub-culture, tradition and structure support groups.
Overt & covert discrimination and harassment.	Lack of female success and under utilisation of their talents and skills.	Mentoring, networking and women role models Enforcement of EO policies.

Outside Employment

Pre-employment socialisation and education – A girl's socialisation can reinforce the subordination and stereotyping of women. It is difficult to combat this influence, but creating a higher profile for

construction in the media and active promotion within schools may certainly go some way towards it. In UK, the Women Into Science & Engineering (WISE) initiative attempts this, by visiting schools where girls take part in a variety of exercises to introduce them to engineering.

General Labour Market

Image and status of the industry – Construction has a strongly male, technology-stereotyped image, and on the construction site, a "tough" culture. This image acts as a barrier to women and is important in explaining the low numbers of women in the industry (Gale 1991). The industry can challenge this image by campaigning for construction to be brought into the national curriculum, visiting schools to give presentations and providing child care, job share, part-time work and career breaks for women. The industry must be seen to be progressive in its outlook to these types of facilities to attract women.

Inside the Industry: Formal Structural Factors

Life cycle restraints – Society allocates family responsibilities to women. Lack of opportunities for job share, part-time work, career breaks and child care leave women having to make a choice between their career and their families, a choice which men are not forced to make (Bagilhole 1994; 1997; 2002). The demanding nature of construction, both in time and energy, exacerbates this problem. A corrective measure could be to implement career break programmes with well-structured retraining programmes. Provision of child-care could benefit many men working within the industry as well as women, and ultimately attract a better quality of entrant.

Working conditions – The nature of construction work at present demands full-time attention to projects, and makes job-share and part-time work complicated. Technological and contractual progression makes career breaks difficult. The way that the industry is structured, therefore, can clearly be seen to work against women with family responsibilities.

Recruitment – Recruitment is often through personal contacts in the profession and many positions are not advertised. Discussions often take place on the sports field or in other places from which women are excluded. Informal recruitment and the "male network" can be broken down by implementing and enforcing an EO policy, and formalising recruitment procedures.

Work facilities – There are few or no on-site facilities such as separate toilets, or safety clothing in appropriate sizes for women. It is often argued that providing these facilities would cost too much in relation to the number of women involved, but it is only through catering for women's needs that they will be retained and attracted in the future.

Dynamic structure – Construction personnel, particularly on the contracting side, continually find themselves moving from project-to-project, working in an intense, fast moving outside environment, often working highly unsociable hours, which conflicts with women's family commitments.

Inside the Industry: Informal Cultural Factors

Construction education – Stereotyped industry values and attitudes are reinforced by lecturers (Gale 1992). Srivastava (1992) found that a tension exists between the EO policies set out by the colleges and how this is translated in practice by the ex-industry lecturers. Thereby they act as "gate keepers" to a white-male industry.

Culture of the industry – According to Handy (1993) people's beliefs and norms form the basis of organisational culture. If people fit into the culture and structure of the firm, then they are likely to be intrinsically more satisfied successful in their careers. In this way the adversarial nature of the construction industry is maintained (Fen and Gameson 1989). Carter and Kirkup (1990) point towards engineering's stereotypically male traits. It is hardly surprising, they contend, that women are not attracted to this ethos of aggression, competitiveness and hierarchical leadership.

An influx of women to the industry could have a profound effect on the nature of professional relationships within it. Gale (1992) argues that if the culture of the industry is feminised, then conflict, the bane of contractual arrangements (Latham 1994), could be reduced. However, these pioneering women would find themselves involved in a fairly "tough" experience, which raises some important ethical questions about this course of action. It would seem that to be successful, women need to break down the male oriented culture inherent within the industry, whilst holding on to their own values.

Whilst so few women work within the industry, one possible answer to the problems is the use of networking whereby women exchange experiences, and discuss ways to overcome barriers to their career development. Removing the feelings of isolation felt by many women in the industry could go a long way to improving retention figures. The advantages of networking include reduction of isolation, and alerting women to vacancies in other companies providing an equivalent to the "male network". Mentoring is another approach which can provide support. The mentor, someone who is in a senior position provides information and guidance to a junior. The current problem with this is that few women exist in senior positions to act as suitable role-models for young graduates and professionals, and those that do have senior positions may well have adopted a male culture anyway.

Methodology of the Project

Very little empirical work had been undertaken on careers in construction, and so it was decided to adopt a "Grounded Theory" approach (Strauss and Corbin 1990), to allow the issues involved in career development and retention of women construction professionals to emerge from the data, and to develop theory pertaining to both the transient and dynamic nature of the industry and its affect on careers, and in particular the disadvantages that women face in their working lives and the effect that this has on their career progression and job satisfaction.

The chosen methodology was to study "matched pairs" of women and men; who had started their careers in a broadly similar way.

It is essential to understand the way in which individuals see their career in the context of the other factors that they consider important in their lives. This involves exploring the informant's personal constructs, the way in which they see and understand the world and where the career fits into this picture (Boyd and Wild 1996). For this reason, a semi-structured, ethnographic interview technique was adopted for the research.

The informants were simply asked to give a career history, explaining how and why their career had developed the way it had, the determinants of any intra or inter company career moves, promotions or significant changes. As issues emerged from the data, they were noted and built into the research instrument to be fed back to future respondents, and thus the findings of the research were continually tested and validated throughout the data collection phase (Kirk and Miller 1986).

The length of the interviews were not restricted. The average interview time was around 1 hour 30 minutes, although it was not unusual for the interview to go on for considerably longer, even up to 2 hours 30 minutes. All of the interviews were carried out in the respondents' natural working environment, but in private such as in site meeting rooms.

The Sample

The sample was representative of all levels and career routes within each of the five organisations investigated. In all, 92 respondents (46 pairs) were interviewed.

The criteria for pairing the respondents is shown below:

- Career path (e.g. quantity surveying, construction management etc.);
- Number of years in the industry;
- Number of years service to the organisation for which they work;
- Educational attainment and other qualifications.

No women could be found in a strategic management position to take part in the study, therefore the sample was from junior and middle management positions.

The data was analysed using the NUDIST computer software package, because it was specifically designed for use in Grounded Theory projects, and for its "user friendliness". It promotes the coding and searching of data but without distancing the researcher from the transcripts. However, to overcome the pitfall of over reliance on the software, some manual analysis was also carried out by reading and developing themes in the data.

Findings

Certain themes emerged from the research which go some way to explaining differential career progression rates between men and women and the poor retention of women to construction organisations.

Falling motivation and reducing expectations: Most of the junior female managers expressed high ambitions to move within their organisation or within the industry generally. This was a marked difference in attitude to those women in middle management positions, many of whom expressed a desire to start a family and take time out of their careers or leave the industry all together. No female respondents in middle management positions expressed ambition to reach the main board of directors, seeing it as unrealistic considering their own abilities or impossible within the context of the organisation.

In contrast to this, male managers of all levels remained ambitious even if their own career had reached a "plateau". It was only those at a senior management level that recognised that opportunities for a board position were limited. Men were more ambitious and saw a real need to reach a senior position where as women saw the need to consolidate their position.

Over half of the female informants were actively seeking employment in either other organisations or outside of the industry, whereas only six male respondents expressed similar wishes.

Career development path and personal development strategy within the constraints of the life-cycle: Many respondents suggested that a "zig-zag" route to senior management was actually encouraged by their employer. This entails moving between organisations as much as possible to gain a wide experience, and taking promotions to more senior positions in smaller organisations before moving back

to their original larger employer. Although some women had followed this policy themselves, many commented that the upheaval in moving geographical location and family responsibilities made this impossible. Men, on the other hand, generally saw no problems with this as a "means to an end" in reaching senior positions.

Career versus family: There was a clear dichotomy between employees who placed their career before their family and/or private and social lives, and those who saw the career as taking a role that is subordinate to their "out of work" lives. Family responsibilities and home life were given priority by very few of the male respondents, whereas the reverse was usually true for women. However, there does appear to be a link between career position, age and attitude: those employees who are successful in relation to their age seem to place more importance on their career, and have higher overall ambition levels. This leads to a lower priority being given to family life.

National divisions lead to greater opportunity for men: Companies with a local and national divisional structure seemed to offer greater opportunity for advancement. However, to work in these divisions requires total flexibility on the part of the employees to work anywhere in the country, or even in other countries. This disadvantaged women who found it difficult to move because of family responsibilities.

Incompatibility of structure, culture and individual's priorities: The company's culture, individual's priorities, and the way in which the organisation is structured, all seem to affect careers differently by pulling in different directions. For example, in one company there was a board directive that the organisation was actively trying to move into European wide markets and that employees wishing to reach senior positions within the organisation must spend a period of time working abroad. At the same time, most of the respondents did not wish to work abroad because of their own personal circumstances, and there was a perception that they would get out of touch with the industry if they worked in a European out post of the organisation. There appears to be an incompatibility, therefore, between the way that construction companies want to structure themselves, the individual employee's needs and the culture that has developed both within organisations and within the industry generally.

Perpetuation of the culture: At senior-middle management levels where the staff have the responsibility for implementing policy decisions from the board, there appears to be a number of managers who have worked their way through the organisation and have very antiquated attitudes towards procedural and work force issues. They appear to see through narrow "management frames" (Seymour and Rooke 1995) and also have considerable influence over who is recruited. They are seen by junior employees as seeking to perpetuate organisational culture by recruiting people who are similar to themselves. It is this group which appear to hold the key to women's future participation, as personnel and training departments, however enlightened about the potential of a diverse workforce, have little influence or power over the ways in which the higher levels of the organisation are staffed. This has long been a problem within construction companies (Hillibrandt and Cannon 1990).

The "old boy network": In a similar way to other industries, construction organisations appear to operate what has come to be known as the "old boy network". This is seen to work where individuals from particular educational and family backgrounds have an accelerated career through the organisational hierarchy, regardless of their personnel ability. For instance, in one organisation many members of the board and of the senior management within the company are keen rugby players and supporters. Many of

the respondents in the study commented how a healthy appreciation of the game, or ability to play it well, could do more for your career than any amount of work-related success within the organisation.

Men in middle-management positions seek to undermine their female peers: Men appear to deliberately try and undermine their female colleagues in an attempt to further their own careers. Many women complained of male managers, and particularly line managers, who tried to gang up on them or create bad feeling with other people in construction teams. Women used a variety of strategies to cope with this problem, but those that adopted a confrontational stance found that problems often became exacerbated.

Conclusions

The research outlined in this paper aims to gain insights into the way in which women's careers develop in comparison to men's in large construction companies, and the way in which current employment practices work against women and thereby perpetuate the loss of talent to the industry, which necessarily must inhibit its development. The findings indicate that there are a number of reasons which explain women's continued exclusion and subordination in the built environment workplace. These stem from attitudinal barriers to women's participation from male managers in middle and senior management positions. A deeper understanding of where women work in the industry, and the determinants of their careers will allow us to create equality of opportunity and improve our management of an increasingly diverse workforce. This will benefit both women and men within the industry.

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Being a woman engineer: Creating a work life balance; an impossible task?

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Abstract

Conciliating work life and private life for women is nowadays common in Europe, as women entered massively in the employment market during the seventies. Several solutions have been set, directed to parents, allowing them to work, both of them, and conciliating work and privacy. Considering women who work as engineers, in companies where it is very common to do not count his/her hours, these problems are highlighted and emphasized. We propose to determinate four key moments within women engineer's careers – First job, maternity, dual career and mobility/promotion – and to study how women engineers deal with them.

WOMENG (a European team constituted of Austria, Finland, France, Germany, Greece, Slovakia, UK) research project's work package 2, concerning Professional Sphere's part, was aimed to the discovering and apprehension of those hindering factors of promotion within women engineer's career. The applied methodology was determined by the collection of job & life stories, conducted by interviewers, towards Women Engineers, Human Resources Managers, and Union Representatives. Cross national comparisons and results are so issued of qualitative methods completed by quantitative national results concerning the percentages and functions of women inside each country's companies.

If having their first job is not anymore as difficult as it was, maternities, dual careers and mobility are still important issues for women engineer, who are in front of a lot of strong and heavy representations, carried both by the company management and way of working, and structural cultural representations. Maternity and motherhood are still designed as "problems" by employers and engineer women, who dare to be seen as bad mothers by the surrounding society, and only as mothers by their employers: women engineer are sailing between these two representations lying more or less strongly above theirs shoulders. After a general view considering the work situation of women among our seven countries, and what is set by the public state to help them when maternity occurs, we'll analyse what is maternity for women engineer peculiarly, and we'll discover then hindering factors (first job, dual career and mobility) resulting directly from maternity's social meaning in companies and societies.

Introduction

We have set different hypothesis concerning the difficulties and hindering factors preventing women engineer to reach the top management or having a career evolution as men may foresee and have. Institutional and historical factors are still present and influent at the management level: companies are a

man's world, and concerning the engineering sector; it is more than a simple appearance: it is rooted in his basis and functioning. Women are tough compelled to adopt strategies to take part in this masculine world, being "in the belly of the beast" (Kvande, 1999).

Women engineer seem to evolve inside frames which they can't really penetrate nor influence. Their way to investigate this space which has historically and symbolically been a masculine one (Faulkner, 2000), is quite restricted. Faulkner (2000), among others (Berner/Mellström 1997; Easlea 1981; Wacjman 1991), has shown that engineers are powerful symbols of the equation between masculinity and technology. Technical competence is generally associated with men (Cockburn 1985; Gill/Grint 1995) and the prevailing cultural images of technology converge with prevailing images of masculinity and power. Ongoing practice of "doing gender" (West/Zimmerman 1991) enforces these experiences of "otherism". As maternity is "doing gender"; it will influences women engineer's careers, and the way companies would handle that peculiar subject. Women Engineers are evolving between two main pressure's objects influencing their career evolution, family life, important decision, and even behaviour. The society intimates to women the well-bringing of their children, and companies would compel them to behave like men who do not culturally have to think about such family obligations. We can easily imagine that in companies such those which officiate in an engineering sector, the action frame of women engineer are all the more as restricted, the designed phenomenon is being reinforced by this masculine "doing gender": working with technology.

Overall presentation of the working situation of women

Some statistics concerning our seven countries

The gender pay gap is quite high (from 13% for France to 22%, Slovakia), so is the percentage of the women working part time, considering the countries where this kind of solutions is proposed to women: Austria: 33%, Finland: 17, 5%, France: 31%, and UK: 44, 4%. For the others countries, we suppose that part time is not so popular, or we can imagine that women would completely stop working while having children.

Inequalities are strong and evident, and, in some aspects at least, seem to get worse. For example part time jobs have increased since 2000: in France it went up from 16, 9% to 31%, in Austria: from 17% to 33%! [1]

What is set to help parents in our seven countries? Society to women and mothers: to the quest of the lost day nurseries!

Maternity leave system can be more or less advantageous for parents: it depends how long does it have to last, and the nature and amount of the help guaranteed to parents. Common lengths (for one and first child) of the maternity leave are 16 weeks for France, 17 weeks for Greece, 28 for Slovakia, 14 for Germany, 16 for Austria, 26 for UK, and 18 consecutive weeks for Finland. During these peculiar periods, mothers must respond to specific criterion to receive the allowance. In Greece, mothers are indemnified for 56 days before AND after the delivery (36 euros a day). The salary is not maintained. In Slovakia, the maternity allowances are provided in the amount of 28 weeks and amount to 55% of daily calculation base

[1] Data: Eurostat

from the previous gross salary up to the amount of 1.5 times of average wage in national economy. In Germany, women are fully paid by their health insurance companies or by government In the UK, the Public Health system is financed by the whole population (taxes) (residency's principle). The health cares are free of charges, granted by the National Health Service. In Finland, the public health service is supplied by municipalities for the whole population (residency's principle). It is financed by the taxes and the patients' contribution to the charges. All the residents are insured. The maternity's allowance could be a maternity bag or a sum of 140 euros (01/03/2001). Your control exam would be free in the health centre for future mothers and children during and after the pregnancy. In France, the social safety will repay the hospital and medical charges of the delivery. The fathers and mothers receive their daily salaries: it's considered as remunerated leaves.

Parental leave, as it is set among our seven countries, is linked to different needs: first: is it advantageous and attractive (amount of the allowance)? Second: Could I find my job back, with the same responsibilities and salary? We know that most of the parental leaves are taken by mothers (generally they have a job with less responsibilities and so a lower salary), moreover, in some countries, day nurseries are not so common, and you have to stay with the child at home. We can take two examples: in France, the parental leave, which can be taken by both parents, has one year length, renewable 2 more times (until the third birthday of the child). The company is in this case due to keep your job, or an equivalent one (included the salary). You can only receive an economic assistance from the "allocations familiales" (For the third child, a parent who would take the parental leave would receive 700 euros/month). By the other hand, in Austria; you can get paid parental leave of 2, 5 years (3 years, if the father takes half a year too). You can go back to your former company, but you won't have your former position, salary, and job back…The parents can also share parental leave time; the problem here is that generally companies more or less openly tell their male employees that if they take parental leave, this means the end of their career.

Taking parental leaves responds to specific criterions more or less visible within countries. Women engineer can barely afford themselves to take such a time to raise their children, if they work in those countries where building babies and children's infrastructures make part of the government's policy as in Finland and France.

What is maternity for women engineer? Reflecting the infrastructures…

The difficulties encountered penetrating hierarchies of companies, creating the famous glass ceiling, are initiated by four obstacles appearing in women engineer's discourse: first job, maternity, dual career, and mobility. We can isolate one of these moments, because it seems to penetrate and nourish the pertinence of the three others. Maternity, motherhood always appear in transparency behind those hindering factors. Infrastructures welcoming babies are reflecting the way maternity is viewed culturally in the designed country. **We have noticed that commonly, when working mothers are assimilated to bad mothers, infrastructures to welcome babies and children are not so numerous and accessible**. The maternity leave system would be a pertinent indicator too, representing the way the given society would support and help families.

Among our seven countries

France

French female engineer associate clearly maternity as a problem: "**: „**and there is the maternity problem too"…"The real impact hindering them to be manager is the family situation" "There is a fear…Women clearly fear about children, dual career, and mobility for their future career". Sometimes, they have to choose: „I want to have a third child; I will not be able to manage my family life, and my professional career!" (Woman Engineer who have quitted). Motherhood induces different feelings of guiltiness towards themselves as mothers, and the needs or pressure of the society: „I have a nurse, but I gave myself a rule which was to be at home at half past six: or I don't have children!" "I felt guilty as I took the maternity leave, and I came back at office just at the day foreseen for it" (Woman Engineer Manager). Guiltiness is directed towards the will of the society, concerning both the raising of children and the lack of prestige of such a situation, emphasized by the possible company's pressure.

Apparently, having noticed the high fecundity rate of the French female, (1, 89 child/woman) in comparison to the others European countries, **maternity, paternity and parental leaves systems seem to be appreciated by parents**. Women engineers can benefit of this system, although it is more difficult for them to take the parental leaves than for women working in the state service. The real problem may be the social pressure which lay on mothers, (especially for younger children that they have to raise by themselves a minimum). Nevertheless, women are not considered as bad mothers if they only take their maternity leave (4 months). The insertion in the employment market concerning mothers is important, but it is thanks to parental leaves and flexibility of working hours.

Finland

In Finland, as in France, parental leave and maternities seem to be a woman's affair… fathers never really appear in women engineer' speeches. "In our family there are twins, four years old, and I'm going to take a maternity leave now in May. I've been on normal maternity leaves, and also stayed at home when children have been ill." (Woman Engineer Manager).

We can see more or less that the situation in Finland seems to be close to the situation in France. The fecundity rate is 1, 73 child/woman**. The maternity and paternity leaves systems are well considerate (fecundity rate is quite high), and the state collective equipment has been massively developed; parents can find easily a structure which can welcome their children**. The child is in the centre of the familial policy, and policies want to promote the equality between men and women (sharing of parental tasks). The welcome of the young child in a formal structure is a legal right.

UK

In the UK, it seems that things are less flexible, the situation seems to be close to Slovakia's: "She's working 37.5 hours per week with 15 hours plus overtime, plus training. And she foresees this to go for 5-6 years. She doesn't think she's purely a career minded woman; she'd like to have a family" (Woman engineer). We can notice within this discourse, that the fact of wanting to have a career, to be careerist is viewed here as absolutely non compatible with having children… **Suspicion is common and seems to be present in the mind of each woman who would try to handle both her career and having children.** Even though women engineer managers didn't mention any problem at all when returning from

maternity leaves in their company (the announcement of pregnancy was well taken)… The highest your position is in the company, the longer are your working time hours…and the less compatible your work life is with your family life. Moreover, women seem to have more pressure for the society to raise children: "Women will always have responsibility for family…She knows of a friend who had to give up engineering completely because she wanted to start up a family" (Woman engineer).

Even if the fecundity rate is quite high, (1, 65 child/woman) and the maternity, paternity, and parental leave systems seem to be quite appreciated, we could imagine that women engineers could be taken apart from the other women: they refer to heavy problems, the fact that they have to make a choice: either career or children. **The social pressure seems to be very strong upon mothers, and women are highly valorised as mothers, but not as workers…** In the UK, the majority of part-time workers are women (81%). In 2003, women working part-time earned just 60% of the average hourly earnings of men who worked full-time. The public offer of taking care of young children is very low; it is relayed by private and local initiatives. Raising children is the designed task of mothers. Mothers can conciliate their family life and work life while penetrating proximity networks.

Austria

Austrian engineer women won't really talk about the social pressure, but it seem to be deeply rooted inside companies' rules: Three of the women engineers who have quitted indicated that if they had left their jobs, it was because of incompatibility between work life and private life**. "In Austria, it is difficult for women to combine job and family planning**. If you stay on parental leave for 2, 5 years there is a huge danger that your knowledge becomes outdated and that you loose touch with your work. In a 24/7 work culture (24 hours, 7 days a week), as it is lived by the owner of the company, the employees as well are expected to sacrifice themselves, work long hours and be available any time. This makes it hard to have a private and/or family life, not only for women. Some employees, men or women, work partly at home. This is not made public in the company and is based on individual agreements." (Woman Engineer).

Maternities are welcomed when the leading management team is open towards those eventualities...

The lower fecundity rate (1, 39 child/woman) can be explained according to the maternity, paternity and parental leave systems which seem to be less secure for workers than the previous countries we just had seen. We can here imagine that women engineers adopt the others women's attitudes towards maternity. The social pressure on mothers seems to be very strong, and easily reflect itself upon companies' lives. We can notice that women engineers really visibly talk about an incompatibility between work life and family life. Nevertheless, the system concerning maternity is quite similar as France and Finland's: the insertion of mothers is quite important, but it is done with the help of parental leaves and flexible working hours, which are still mainly women's choices. The welcome structures concerning young children are not so developed as in France's. 50% of the collective day nurseries are private ones. Public child care facilities are not provided enough in Austria; all-day schooling is only in discussion. Women were expected to be mothers. Working mothers are uncaring mothers.

Germany

The women managers in Germany did not have any problems when taking maternity and parental leave. Nevertheless, all participants of the focus groups have fear of getting into trouble and loosing career options when getting children and taking maternity and parental leave. They would recognise that working part time is not career promoting in all levels: to reach the management level by working already part time is nearly impossible. Nevertheless 2 out of 4 women managers having children reached their positions by working part time.

The maternity social system is not so advantageous than in the previous countries: it could explain the lower fecundity rate (1, 36 child/woman). **The problem is to find a good work life balance, which could allow you to evolve in your job and be a good mother.** By the way, to take care of children is considered, in Germany as in UK, as a private arrangement. Kinder gardens for children who are less than 36 months are quasi non existents. 40% of the women who attended university did not have children. And 49% of mothers have a part time job. Women who worked and had children at the same time were called a few years ago "women who abandoned their children". The main problem, as in UK, remains in the lack of institutions concerning the care of little children. In Germany, as in UK, one woman on four who had a child does not work during the year which followed the birth.

Slovakia

The situation in Slovakia for women engineers seems to be really hard: we can notice that the **social pressure against women is very heavy: women have to put in parenthesis their careers while children are small.** "After coming back after the second maternity leave she realised that it was right time for the career. She wanted to build her career already at the very beginning, after her graduation and with her first job but then the children was born and she felt that she had to focus her attention on the family. It seemed to be a natural development for her: first family, children then when a care is taken of children and they are older the time for career comes"…" Choosing, according to a woman engineer who have quitted engineering, between job and family is still an "eternal dilemma" (Women Engineer). Externalised domestic work is still not very popular; many women cannot afford it, many are not simply used to the fact that there is sort of "an intruder" coming to their house.

We can explain the low fecundity rate (1,3 child/woman) with the **maternity social system being so disadvantageous, taking away women from the employment market for a very long time** (ten weeks more than the average maternity leave length in Europe). In case of restructuration of the company, women represent the "easiest victim…"

Greece

In Greece, According to the three women engineers who have quitted; **conciliating family and work life appears to be the number one factor which could lead women to quit.** "The company did not support the employees at all, apart from providing the parental leave and the reduced working hours to some young mothers. Additionally, they wanted staff to be available the whole time, the work load was always too heavy and they did not pay for the extra working hours». The Private Sector is very tough, especially for young mothers. Issues like paternity leave and reduced working hours are not taken into serious consideration

The social system concerning maternity is not advantageous: it may explain the low fecundity rate (the lowest of our seven studied countries: 1, 29 child/woman). Besides, inside companies, solutions concerning the arrangements for children are proposed to women, and consequently they will not be taken into consideration. **Welcome structures for young children are rare, and familial solidarity is very important. The full time job insertion is weak among Greek women.**

We can notice that when there is pressure on women concerning the way to raise children added to a disadvantageous maternity leave system, we obtain generally a lower fecundity rate (as in Slovakia). UK, Germany, Greece, and Slovakia female engineers have the highest problems, due to a more or less but high pressure lying heavily on women, concentrated in the family life, and producing an incompatibility between work life and family life. Besides, these countries dramatically lack of infrastructures dedicated to children, especially infants. As a hypothesis, we could link the fact that when problems brought by maternity are lying into more into work life than family life, you can suppose that countries are though well equipped in kinder gardens infrastructures and the fecundity rate would be not so low (France, Finland). For those peculiar countries, we can add that the maternity leave social systems are advantageous too. It is though stunning to view how maternity is seized with a great fear and apprehension by those women: it is always linked to negative situation which have been, are, or would be happening according to those women.

Women are first mothers!

First Job and career development

Finding the "first job" make part of a link representing the future evolution of the career.

Women engineers have not encountered peculiar problems to find their first job. They do not talk about difficulties concerning that key moment, and sometimes link it to the good economical situation when they had applied for a job (Germany).

Concerning the recruitment, **best practice companies**, recognising the business case for employing women engineers, do include visible strategies to attract women, such as indicators appearing in the recruitment corner of their web sites. **Diversity, gender sensitive language, policies to grow its employees through continuous training, promoting work/life balance, monitoring for new comers, flexible work arrangements would be such measures highlighted by such companies**. Being promoted includes the completion of certain training (as team building, conflict resolution, equal opportunities in selection and interviewing).

We should remain that we did our field work in large international companies, even multinational ones: so the overall picture in each country may be worse than what we are painting… (In medium, little companies).

Dual career: The importance of the support of the family, peculiarly of the husband

In Greece, dual careers' problems occur generally when the husband and family offer support or not… "Her husband was very supportive. On the other hand, her children complain for the hours she is not home" (Woman Engineer). The idea of making a career is strong when the partner is supportive and when there are not the criteria "children" yet which could influx.. **In Slovakia**, gender differences of labours

appear stricter than in the others countries: "Two career couple is a big problem in Slovakia, but with many families it is necessary. Many women would prefer not to work and stay with their children or to work part-time" (Woman Engineer).

In Finland, problems of dual career are not clearly mentioned: women engineers wouldn't want to have separate policies set because of the sex of the person. Nevertheless, problems encountered by women may be the "use of time. When teams take responsibility of the assignment, the schedules are often strict and it is not wise to separate the work to female and male work. For this reason sometimes women also have to work through the night." (Woman Engineer who have Quitted). Concerning **France**, in one case, the partner may have been the element who has influenced her spouse not to take a promotion, which was abroad; he didn't want to loose his job. In another case he did not help at all his wife for the children and house. Another engineer woman indicated that she had always followed her husband, promoted, and that while he was making a career, she was not: finally she was dismissed at 50.

In Austria, the question of dual career is really linked to the husband's open mind: some husband help at house, others do not, some benefice of the support of their companies, others don't… **"**She says it is not easy to support job and family life at the same time: her husband would have found humiliating taking a parental leave" (Woman Engineer). **In Germany**, two women had a visible interdependence between private and professional sphere. One has been divorced because of estrangement from her husband caused by her heavy work load. The other got separated because of estrangement, too (the other reason had been her career: her partner did not like her having a better position than him).

We can establish a scale comparing countries in which problems regarding dual careers would be more or less penalising for women. In Slovakia, Greece, and UK, dual careers problems seem to be linked to women and maternity's statute. In Finland and France, dual career is mentioned inside the work sphere, not really inside the family life: it appears to be more a work strategy elaborated by spouses. In Germany, as in Austria, over work loads and coming home late do not correspond to the image of women who have to take care of children; the image of the "caring woman" seems to be very present: dual careers problem would be more the difficulty to combine and conciliate work and private life.

Promotion & Mobility

In France, mobility is evoked both in the Good Practice Company and Energy Company, and is linked to difficulties factors (dual career, maternity… careers' development). "The mobility promotes promotions. And when you reach a specific age, offers are less adequate with your competencies and experiences: there is a stagnation of the careers of women from a certain age. You have to play the mobility game" (Woman Engineer Manager). In the Energy Company, it's more radical: "you have to be mobile if you want a promotion" (Woman Engineer). **In Finland**, promotion and mobility are included into the work life balance problem experienced by women. **In Austria**, mobility question is related to family: if women have no kids, well, they can be mobile … **In Germany**, none of the women managers did have study or job experience abroad. Neither the Human Resources Manager nor the Work Council Manager mentioned those experiences as a career supporting factor.

The others studied countries, as **Greece** and **Slovakia** don't seem to be concerned about this mobility question being a promotion criterion for women engineers: women engineers don't mention at all this problem of mobility: **In Greece,** women engineers are presented as mothers before wage earners by the companies. **In Slovakia**, it seems that we are in a more traditional way of life: "Family has always been a

priority number 1 for her…She prefers family to career; career is always at the second place. However, she would like to get promoted at this time" (Woman Engineer). **In the UK**, mobility is linked to the solutions proposed to women who have children: Women engineers would so incriminate the fact that they would not be promoted because of rare offers to mobility due to part time jobs.

Greek, Slovak and German women do not talk about mobility: is it because they stay away from mobility and so from promotion intentionally? Do they auto-limit themselves, because of the lack of kinder gardens infrastructures, are they not asked to be mobile, or do they consider that, as women and mothers, well, they can't be mobile (social pressure)? Austrian female engineers mention the subject and rely it strongly to family, while French female engineers mention it within work life balance, and so it is distinguished from promotion. Mobility appears to be linked with the lack of kinder gardens infrastructures, and social pressure stereotypes anyway.

Some women engineer talk about the question of mobility: others do not. Do we have to suppose that women who do not talk about mobility are not asked to? This will remains as a hypothesis. **Nevertheless, in some countries, mobility appears as a hidden but real factor of promotion, in others, mobility is not present, but the question of work life achievement is highly questioned.** These mobility and promotions questions clearly appear, to women engineers from the seven countries, as closely linked to the family question. The more family and work life achievement is present, the less mobility appears…

Solutions set by companies: Directed only to mothers or both parents?

The tenuous differences brought by Good Practices set in Companies:

Good Practices companies are more or less transparent, efficient and honest towards policies set in favour of women. Nevertheless, they facilitate the work life balance achievement for women, setting programs and policies in favour of women (part time, flexible working hours, teleworking). If these measures may help women in their arrangements concerning the taking care of children, it would not lead to promotion either. Both availability and mobility still represent the main promotion factors, and decision by a woman to refuse to be mobile would be accepted, but she would loose chances to be promoted again.

Non Good Practices Companies merely do not accept to divide women who are mothers to the others women. Even if solutions exist in those companies (part time, flexible working hours, teleworking) there will be no special policy for women who are mothers: they just have to organise themselves, and to handle all of it. Those solutions are here disapproved, and represent a visible, and not hidden (as Good Practices Companies) factor of impeachment to promotion. The pressure lies more heavily on women, and to talk about work life balance achievement is neither interesting nor important.

Conclusion

"Doing gender", being pregnant, becoming mother is still assimilated as a "problem", even in the countries which are the best equipped in infant infrastructures. The more maternity is exempted from cultural pressure, the more infrastructures would be set, the more women, peculiarly in our study women engineers, would profit by a harmonious work life balance.

The determinant and pertinent factor is certainly the society pressure, which would describe working mothers as bad mothers, or not. The more this factor is emphasized among our seven countries, the more women engineer would evolve in a restricted frame of action, horizontally and vertically, in companies. By

the way, for the worst cases, they just disappear of the engineering sector, dropping out to take care of their children (or they don't have children).

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To succeed or not succeed, that is the woman engineer's question

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Abstract

"We want to employ more women engineers, but they do not apply." "We want to promote women engineers, but there are so few." These often heard statements from managers focus only on the women's part of the puzzle of women engineer's success. But beside internal factors there are also many external reasons for the underrepresentation of women engineers in companies and there are far more external stumbling blocks on their career paths.

In about 100 interviews with women engineers and managers of companies from Austria, Finland, France, Germany, Greece, Slovakia, and the United Kingdom it could be shown that various internal and external factors influence the success of women engineers. And while some well known internal factors like interest in engineering or motivation are relevant for women engineers in all countries equally, others like perfectionism or humour are only influencing women engineers in some countries. Also some external factors like networking or the influence of the application process were mentioned just in some countries, while other external factors like the importance of family organisation or sexism and discrimination of women engineers in companies are relevant for all analysed countries.

But although the factor "sexism and discrimination" results from interviews in all countries it does not necessarily mean that its influence is everywhere the same. This paper takes a closer look at the examples of this major influencing external factor. That means that even if sexism has a general impact on women engineers' careers, country specific differences play an intervening key role for women engineer's careers. This leads to the conclusion that it is important to consider country specific differences in the deduction of recommendations to create cultures of success for women engineers.

Introduction

Whenever women enter a so called male domain they encounter similar mechanisms related to their minority status, be it as a science or engineering student, as a professor at a Technical College or University, or as an engineer in a company. The ongoing practice of "doing gender" enforces this experience of "otherism". The historically grown link of technological competence with masculinity is extremely persistent and changes only very slowly. Above all, many stereotypes of engineers influence the image of engineers. For instance engineers are seen as machine-oriented, logical, rational persons with less sense of emotionality and less caring or cooperating qualities. Usually those qualities, which are connected to engineers are attributed to males while those lacking qualities of engineers are ascribed to females (Thaler 2005a). Faulkner (2000) pointed out such dualisms in engineering.

One reason why such gender-related stereotypes are still so persistent is ambivalent sexism (Glick/Fiske 1997). Ambivalent sexism is a more subtle form of sexism where the well-known negative and hostile aspects are combined with apparently positive (so called benevolent) aspects and both appear like two sides of a coin. For instance while the one side tells about the stronger people-orientation of women, that this is so important for engineering, and therefore more women should go into the field of engineering to improve this field. The other side, however, says in a whisper that women are not so machine-oriented, not so rational, logical and whatever it is what engineers should be to be treated as competent engineers. And just because the compliment of people-orientation sounds nice it cannot balance out the disadvantages of being called less machine-oriented, less logical or generally less competent, because that are the qualities which are connected to the stereotyped image of a proper engineer (Thaler 2005b).

But to manage the demands of a knowledge based and technology driven society it becomes more and more necessary to make use of the potential of women. Beside the argument of equality it is also the goal to diversify the participation in shaping our future which should be kept in mind. A retreat from this field would not only assign women the status of mere technology users but would, furthermore, minimise their chances to actively participate in designing the world according to their demands (Wächter 2002).

Methods

The main hypothesis of work package 3[1] called "Success and Non-Persistence" was that for women engineers internal and external factors lead to gendered differences in expectations, experiences, needs and demands, associated with developing their engineering careers. And on top of that, factors that influence developing an engineering career had to be investigated.

According to the overall agreement of the WomEng team in each of the seven participating countries a Production Company and an Energy Company had been chosen for the research area of professional sphere. One of the chosen companies had to be a good practice example concerning gender fairness. But the term "good practice" can lead to misunderstandings. Good practice belongs always to the circumstances and overall situation in a country. For instance, while both German companies have installed diversity programs and initiatives to recruit more women engineers, the Austrian good practice company has none of both, but in comparison to other Austrian companies the good practice company supports women engineers more.

The fieldwork comprised semi-directed interviews with two to four women engineers, with one Human Resources Manager and with one Union representative or member of work council in each company. Beyond that focus groups with three to six women engineers in each company took place and we four female engineers who quit were interviewed. In total, at least 12 interviews and 2 focus groups (with at least 3 women engineers) were carried out in all seven involved countries.

In addition, we wanted to compare the real working situation of engineers with the image of engineers, so we asked over 1300 students, from engineering degree courses and with other majors, from all seven countries which qualities they associate with female or male engineers.

[1] Christine Waechter (IFF/IFZ, Austria) is the responsible work package leader.

Key Results

Hindering Factors

In the companies, a frequent message was, "We would employ women but they do not apply for vacancies." The companies often see the main reason for this in the low number of female engineering students. And they argue that the dilemma begins in the families and in kindergarten, and continues in schools and universities where more and more females drop out of the system until finally only very few apply in the company. By the way in some companies the proportion of women engineers is lower than in the engineering degree courses. On the other side we interviewed also faculty members in the WomEng project and they said that for instance there must be more female role models in companies or that society and politics have to do something against the bad image of engineering. So the issue reminds one of a hot potato which is thrown from one responsible to another.

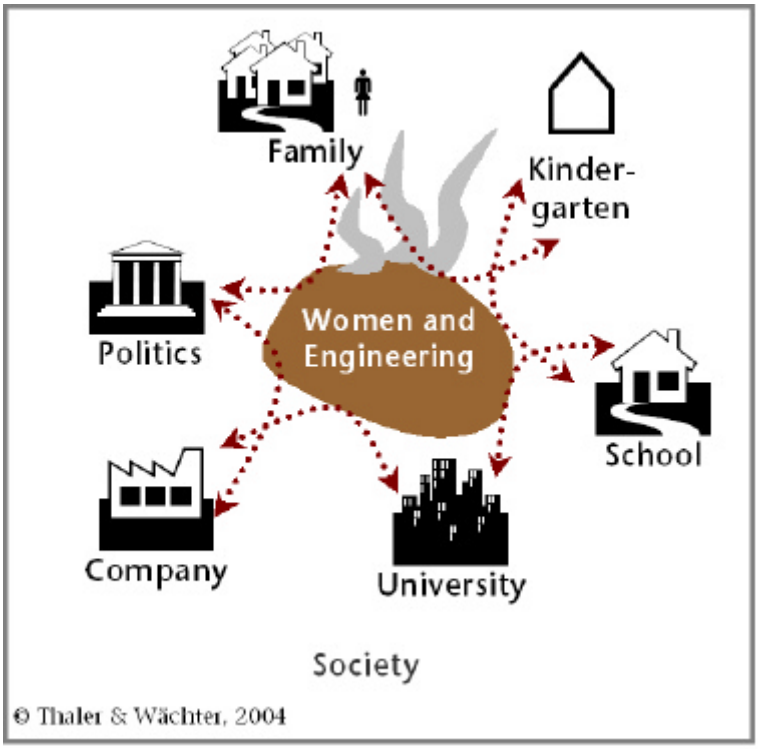

Figure 1: Hot potato model (Wächter 2005)

But this study could show that beside well known factors from other parts of the system, a lot of stumbling blocks can be found in companies themselves. After having successfully managed the cliffs of technical training and education, the women are confronted with heavy storms on the sea of the job market. The interview partners from company management no longer used the pseudo-argument "A woman could become pregnant.", and on the surface they support the matter of getting more women engineers. However, there is evidence that the close connection of engineering and masculinity is still one of the biggest stumbling blocks for women engineers.

One of the results which leads to this interpretation comes from the questioning of engineering and non-engineering students which took place in the first part of the WomEng project in the field of higher education. It could be shown that the images of engineers that students with different majors have in their

minds are strongly gender-stereotyped. That means students associate typical engineering qualities more with male engineers and so called soft skills with female engineers.

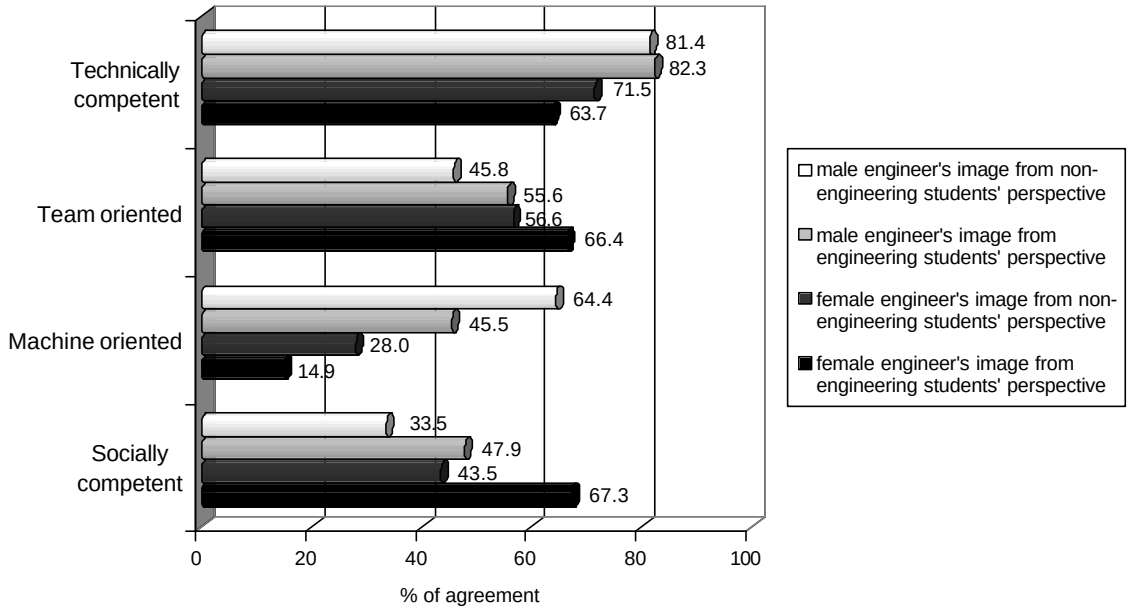

Figure 2: Students' image of female and male engineers

The questioning of 1336 female and male students showed that technical competence and above all machine orientation are more connected with male engineers, while team orientation and social competence are more ascribed to female engineers.

A closer look at the sample shows some differences. The 637 non-engineering students with majors like economics, philosophy, natural sciences and sociology have generally a more machine-oriented and less socially competent image of engineers than the 699 engineering students. The gender gap within the qualities of technical competence, team orientation and machine orientation is nearly the same in both samples. But there is another image difference which looks interesting. While the gender difference at the quality of social competence is just a small one in the sample of the non-engineering students, the engineering students see female engineers as much more socially competent than their male colleagues.

If these results can be transferred to the professional sphere, we have to expect engineers who think that female engineers are less technically competent, less machine oriented, but more team oriented and more socially competent than their male colleagues. One negative aspect of that would be that female engineers are expected to be better communicators and more interested in people's interests and needs. But the other more dangerous part is that women engineers are not seen as equally competent and technically interested as men.

This evidence for the strong link of engineering with masculinity can be explained with the cognition-psychological concepts of stereotypes or schemas (Valian 1999), but it can also be seen as an indicator for ambivalent sexism. This modern sexism concept says that women engineers are accepted and treated well if they fit to the traditional image of social and caring females, but at the same time they are not seen as competent as male engineers. In fact, women engineers told us in interviews that they have to prove their

competencies everyday anew. Whereas male engineers are perceived as competent from the start, women do not get such confidence in advance. Even highly qualified women engineers feel they have to work harder than their male colleagues to get the same recognition and appreciation. They have to convince their surroundings that "being female" and "being technically competent" is not an oxymoron or a contradiction in terms. That means first of all that the results of the students image of engineers can actually be transferred on the professional sphere as well. And secondly it proves that ambivalent sexism exists in both fields, in higher education and in companies.

Directly asked about discrimination, the majority of women engineers answer to direct questions that they have not experienced serious, open discrimination. However, they report various examples of unequal treatment, but those occasional examples of discrimination were usually attributed to personality differences rather than to gender.

One of the main reasons for not wanting to work in such a male dominated field anymore is that an unreasonable amount of their time had to be spent not on furthering their careers but rather on fighting stereotypes and discrimination, an entirely different line of work altogether from engineering and something that most people generally of all backgrounds have little or no expert experience in effectively dealing with, especially the institutionalised kind.

> "Women don't want power, but we try to train them to deal with it also." (Finnish female Human Resources Manager)

More subtle discrimination is not recognised as such either, or the women engineers simply put up with it and belittle it. Putting as little attention and emphasis on gender discriminatory unfair treatment may be an unconscious coping strategy.

Contradictory, as many statements were, almost all women engineers report sexist jokes and other macho, discriminatory behaviour.

> "If a woman has a problem with her team, everybody would perhaps say, while laughing, '*She has her menstruation*'." (French Woman Engineer)

Discrimination can also come from other women. Incidences were mentioned, where secretaries openly favour junior male engineers or it seemed women engineers had to wait longer for tasks to be finished. One possible explanation of this "doing gender" is the perceived threat that women in traditional jobs experience when confronted by women in non-traditional jobs, like women engineers. The concept of what it means to be a "real woman" is heavily questioned.

> "Women are more sensitive, they should do some workshop working on their psychological difficulties." (Greek female administrative staff of the Human Resources department)

Women engineers have to show consideration for males, they have to be the socially competent ones and act as conflict moderators. They talked about not being taken seriously, and the difficulty to make a career, and being judged negatively on the fact that they would want to work part time. Often they are seen as a secretary. A man with that education would never be employed as or mistaken for the secretary in this company. Women engineers were accused of being too emotional when they argue in a meeting.

But beside that benevolent side of ambivalent sexism which connects traditional stereotypes of emotional and caring qualities to women, women engineers also face the hostile side of this sexism coin.

> "I heard a male teacher saying, '*Females just make it, because of their short skirts!*'" (Austrian Woman Engineer)

More than once it was reported that, on paper, women and men have equal access to further education and training. In some cases, however, at the end of the year "the budget" did not allow women engineers

to attend courses selected and agreed upon with their superiors earlier on in the year. The women engineers have gotten used to being in a minority and have a self-reliance and self-confidence that will carry them through if there is no significant institutionalised sexism or discrimination that erodes it. Especially the young engineers are not aware of any.

> "I heard someone at a talk saying, '*If you want to get on in engineering you had to be male, first born son, work abroad, play golf, and either be into rugby or sailing*', and that was a description of every director or managing director of every engineering consultancy in the country at that time!" (British Woman Engineer)

They also have to face traditional stereotypes. Women are seen as the ones responsible for housework. It is being assumed that every woman will have babies and stay 2 or 3 years at home. It is also perceived as "the woman's" problem how to combine family and work. Men who want to go on paternal leave are being ridiculed. However, not having children is also held against women engineers, then they have failed to be "real women".

And sometimes sexism does not hide behind stereotypes and is said openly, but that makes the situation for women engineers not easier.

> "My prospective employer told me, '*You have two major shortages: you are young and a woman!*'" (Slovak Woman Engineer)

As long as women engineers are a minority the gender aspect will dominate the professional aspect since the gender role spills over into professional competence. Individual, singular women engineers are more visible than the majority of their male colleagues and are seen as token women. Much of their energy goes into rituals of adapting to the male environment and culture. Only if they can reach a critical mass of at least 15%, better 30% can they assert themselves, can they contribute with their qualities and can they express their requests and demands as a social group (Kanter 1977).

Hindering factors at a glance

External and organisation / institutional hindering factors

- A sexist work environment (sexual harassment, pictures of nude women in the production line, male colleagues taking clients to strip bars, etc.) – often hidden "in jokes" –, with a strong gender segregation, creates a basis that is not supportive for women engineering careers.
- Women engineers are underestimated and get low respect.
- Not being taken seriously as an engineer (constantly having to prove their competencies, being addressed as "the secretary" or being treated as "the assistant" or like a child in a father-daughter relationship, to name a few examples).
- Men are better paid for same or similar work. Their competencies are valued higher. Women's skills are not recognized and not valued.
- Presenteeism, expectations for an all-time availability, meetings in evening hours or on weekends, expectations to be mobile – all these are big barriers, especially for parents.
- Balancing career and family is generally perceived as a female problem.
- Lack of mentors and networks. As far as women networks are concerned, they are mostly "networks of the powerless".
- Frustration coming from witnessing male colleagues being supported, pushed into careers, groomed for success, getting promoted faster, receiving preferential treatment, while women have to fight for their careers.
- Part time jobs are a career hindering factor as well. They lead to fewer social contacts in the company which also results in lack of information.
- Inefficient or insufficient information flow and a lack of encouragement to apply for vacancies in the company.
- Stereotypes like, "Women do not want to commit and have a career.", "Women will get pregnant and stay away for two or three years.", "Women as mothers are not good at work.", "Women have no leadership qualities.", "Women are not good at engineering."
- A dominant male culture and bias in the make-up of teams can be mentioned as a further drop out reason. The effects of which include such uncooperative and unproductive behaviour as the arbitrary dismissal of ideas and suggestions coming from women engineers, which can be seen as an attempt to reinforce the stereotype that women do not have such expertise to offer. In these terms where women are the minority and treated as subordinates they rightfully feel excluded.
- Discriminatory processes that arbitrarily favour men for further training.
- Women are judged more harshly than men if they make mistakes.
- To expect from women that they have higher social skills, simply because they are women, is discriminating as well. Not only does it put pressure on women engineers, but that "extra bonus" of social competencies is not valued, and does not result in a higher salary.
- Difficulties for dual career couples have been reported by many interviewees. The women are expected to subordinate their careers and follow their husbands / partners. Some partnerships / marriages have broken up because of the pressures caused by irreconcilable job and family lives.

Internal, subjective / personal hindering factors

- Perfectionism.

Supportive Factors

Speaking of supportive factors means not only gender fair working conditions but also the support of women engineer's careers. Although one has to say, that the definition of career depends on the individual woman. The women engineers emphasized that success in their career depends on themselves. Also your own point of view on success matters. One can think that she has succeeded in her career when she is responsible for many employees, or she has created new things, or that she found small successes in the end of everyday work life.

The word *satisfied* came up surprisingly often in different interviews. If you are satisfied with yourself, job and career, then you are successful although an outsider might not see it that way.

Some women engineers report that they do not want to have a career in management. They like engineering and want to work as engineers and not as non-technical managers. They aim at a horizontal career, making the most of their engineering competencies, e.g. as team leaders or project managers.

Supportive factors at a glance

External and organisational / institutional supportive factors

- An interest in the subject and a motivation for an engineering career that has been fostered and supported by family and friends, especially parents and partners.
- Role models also help.
- A friendly, non-sexist work atmosphere.
- Flexible job models and working hours, teleworking, part-time jobs, as well as child care facilities in the company are supportive factors.
- Mentoring and networking are crucial, not only to have access to informal information but also to work on personal coping strategies and to learn from others.
  Mentoring is a career supporting factor for all women engineers. The mentor has to be several levels higher so as not to build up any competition with the direct superior of the women engineers. Mentoring would reduce discrimination due to not having access. Mentoring will help to get access to networks and will help women to become top managers.
- An active top down management strategy to increase the diversity in the company is another external supportive factor.

Internal, subjective / personal supportive factors

- A strong self-confidence, based on an interest and motivation for the field.
- A dedicated commitment to achieving realistic goals and a high degree of self-discipline.
- Communicative skills and a good portion of humour are also vital for persisting and going on.

Country specific results

Not only in Austria, to overcome historically grown patterns and resistances, a broad variety of programs at all levels of education and professional sphere is needed. Better work-life balancing opportunities, such as more child care facilities, consciousness raising for fathers on parental leave, part time leadership, role models, to name a few activities that have to take place in order to create cultures of success for women engineers.

In Finland, gender equality has reached a high level. There, women in engineering as well as in many other fields and hierarchies can be found in greatest number than in many other European countries. However, measures have to be continuously implemented and increased, so that in the future, having a reasonable work-life balance does not interfere with career plans of women engineers and vice versa.

Diversity programs make a company stronger, as the French example of Schlumberger shows. A strong commitment from top management is necessary to implement voluntary measures. A quota system only works if there are also consequences for not fulfilling it. However, a quota system also has disadvantages like branding women as "quota woman" and thus degrading their competencies.

For Germany, the broad variety of programs recruiting women seems to be successful and should be continued. Women managers combining family, career, and work-life balance should participate in those programs as role models to show the broad field of possibilities to find the own way of life priorities. Young women engineering students should be strongly advised to do internships or project work in big companies to get used to working atmosphere and to become part of the company network.

Most of the interviewed in Greece were of the opinion that stereotypes should be combated and the state should support the family and especially in the process of raising children. Companies should promote and implement equal opportunities policies and women should focus on constant vocational training. In addition to this general training, education on managerial issues is very important for the empowerment of women, the development of their skills, and their promotion to management positions.

In Slovak companies, even the most basic steps have to be taken to raise awareness about gender equality issues. Gender stereotypes are still very prevalent. In addition to measures within companies, consciousness raising programs have to address the stereotypical representation of women, and in our case women engineers, in school textbooks, in the print media, on TV, etc. likewise. Engineering competencies of women have to be made public. Work life has to be structured in a way that women engineers can have a life outside their job commitment as well. This means that responsibilities for household and family chores, too, have to be shared more evenly between men and women.

For the United Kingdom it was suggested that a key thing to consider would be to improve childcare schemes. The provision of longer paid paternity leave to be taken at a different time from the mother, similar to Scandinavian models, is seen as a good idea. Where both parents worked for the same company this would mean at any time one of them would be present and they could alternate periods of unpaid leave also.

Conclusion and recommendations

It seems that women appear to play only a minor part in technology design and technology politics. However, it is not women's deficits that provide a gender gap in engineering but rather is a result of established, patriarchal structures of teaching, and working climate, content, and context in technology fields. Therefore, higher education institutions and companies are challenged to adapt their environment, and to reflect an equal consideration of the needs of all (Wächter 2003).

Companies must become active and make a clear statement that they are willing and going to hire technically qualified women. They should get inspired by good practice examples in their industry field. Consequently, they should implement gender mainstreaming to profit from a higher number of women engineers, career advancement for women, work-life balance for both women and men, and, in total, a

higher degree of transparency and fairness. Good practice companies have a 'code of conduct' that does not allow harassment or 'macho' behaviour and they expect standards of conduct that favour the inclusion, or at least minimise the exclusion of women and other minorities.

The WomEng project has confirmed that there is still a long way to go until gender equality in engineering is achieved. Apart from necessary changes in teaching contents and contexts, a stronger focus has to be put on how career paths, work lives, and job profiles are presented and that these appeal to both sexes as well as to target groups that do not correspond to "traditional male standard biographies", and through which the "staying on" of women in minority positions can be supported. To ensure a qualitative, vertical feminisation, it is necessary to foster the "getting on" of competent women in bigger numbers on all hierarchy levels in companies and universities likewise (Glover 2000).

In addition to implementing gender-sensitive recruitment policies, their outcomes have to be controlled and evaluated. Governmental affirmative actions programs in the USA and the UK have proven successful by means of coupling equal opportunity policies with government contracts or public funding. Annual reports on employment equity and their outcomes should be established as standard procedure. This would contribute to more comprehensive, gender-specific company data which up to now have not been available.

Recommendations at a glance

- Gender mainstreaming as top down strategies with a strong commitment from management
- Diversity Program
- Installing an equal opportunity officer
- Sensitising management towards the special situation of women in a male dominated environment and training them in non-sexist work culture
- Sensitising and consciousness raising among the male engineers in particular, but also for women, with regard to discriminatory and gender-specific behaviour
- Training in rhetoric, self-assertiveness, communication strategies, and self-defence to strengthen and support women engineers' personalities
- Quality Management: investigating and documenting the work conditions and work-life balance of both male and female engineers
- Creating and maintaining a non-sexist working atmosphere
- Using gender-sensitive language in written and oral communication within and outside the companies
- Re-entry programs during and after maternity / paternity leave, including further training during parental leave to make re-entry easier
- Child care facilities in the companies and co-operation with child care facilities
- Measures to support fathers
- Support for dual career couples
- Networking and mentoring for women engineers and female junior employees within and across companies and with female engineering students
- Flexible job models, flexible working hours, teleworking, part time jobs
- Part time career paths for males and females ("managing part time")
- Female engineers as role models visiting schools and universities

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Women Engineer Managers in Europe – Working Circumstances and Organisational Culture

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Abstract

Women engineer managers in Europe are still a small group in comparison to their male colleagues. The WomEng Project investigates on women engineers, and the organisational culture and the working atmosphere have been the research focus of WP IV (leader: Dr. Felizitas Sagebiel, BUW, Germany).

The main fields being questioned are the decision of priorities between professional and private life, the personal coping strategies, the importance of working atmosphere and work contents, and the genderedness of leadership concepts.

To get information and impressions about organisational culture and atmosphere qualitative interviews have been necessary, and it turned out as difficult to understand and interpret the answers and commands which have not been given directly, but very often had to be read between the lines. A previous knowledge about the culture and the language of engineers had been helpful.

Even if the decision had been to choose big companies for the research work, there is a difference between the sizes of the companies in the member states. The size of a company seems to have an influence on the organisational culture.

The results of the different team member states differ, but a development and a change of image and behaviour of engineers can be noticed.

The European landscape is coined by Finland on one hand showing a straight women promoting culture by having the social environment of a women supporting atmosphere, and on the other hand Slovakia and Austria still showing a traditional view of engineers and their images.

1 Introduction and Research Approach

1.1 Introduction

The WomEng-Project in its third phase deals with the professional sphere and concerning to work package 4 with the organisational culture and work circumstances of women engineer managers to identify gendered institutional cultures and structures in professional sphere.

It has been analyzed if and how the organisational culture influences the developing of engineering career from a gendered point of view. The possibilities to create a women supporting atmosphere by changing the gendered institutional cultures have been analyzed, too. This paper gives a view at the results of the

data concerning to the organisational culture in professional sphere. Work package 4 contains a lot of more information and results given in Draft of D16/17 (Hoeborn 2005).

1.2 State of the art

The world of success is described as a 'macho' culture encouraging long working hours, competitiveness, lack of mutual support, lack of team work, strong networks, especially the field of engineering and techniques got those connotations.

Various studies (McLean et al. 1996; Godfrey 1995; Janshen 1990; Sherriff 1994; Kuark 1994; Roloff 1989; Bluemer 1993; Sagebiel 1988; Sotomayor Torres 1985; Marry 1989, 1992, 1994; Tonso 1999) have shown that women keep themselves away from technique and engineering not caused by women's deficits in abstract thinking, etc. but the content and climate prevalent in technical institutions, this field of "dominant masculinity".

Characterization of engineering culture and structures in education and professional sphere as masculine means that because of the minority status of women, this field is characterized by (dominant) masculinity as hegemony (Connell 1999). This dominant masculinity affects university and faculty structure and culture during both the education stage and the professional sphere in engineering alike. For theoretical analysis we can refer on critical men's studies (Connell 2000; Höyng/ Puchert 1998; Meuser 1998) besides feminist research. Their main concept is masculinity and hegemony, how these go together, and partly how it can be changed.

Bagilhole and Goode (2001) have argued recently that women's lack of progress has its roots in an unacknowledged and implicit patriarchal support system that favours and rewards most men and excludes and undervalues most women. They argue the 'reward of individual merit' is a myth since those who progress do so with the tacit help, support and recognition of their male peers and mentors. Since women exist at the margins, this help and support is generally denied to them. Further, if women complain, ask for support or try to set up their own networks they are generally made to feel that the fault is somehow with them, that they are in some way 'incapable'.

Etkowitz et al. criticise the 'critical mass' concept in higher education, this concept might be transferable also to the situation of women engineers in professional sphere. "We have found that 'critical mass' is meaningless when women are isolated and unknown to each other, when affiliation with other women is too stigmatising, or the female faculty model available reflects an archaic, male stereotype impossible to emulate or incorporate into a contemporary professional identity" (Etkowitz et al. 2000: 245). Furthermore, 'supply side' approaches, trying to increase the number of women entering career education, need to be "supplemented by a focus on changing the institutional structures where science takes place" (Etkowitz et al. 2000: 244).

On the basis of these and other comparable findings, it becomes more obvious that it is not enough to get more girls and women into Engineering, Science or Technology, measures have to be put in place to ensure their greater retention and to move towards more equal treatment of them in the professional work-place.

The research of the WomEng project was based on the given state of the art.

1.3 Hypothesis

The research pointed out that the combined masculinity and engineering is the most prominent barrier for women friendly cultures and structures. Out of this statement three research questions can be developed: The first one is to prove if the barriers for the career of women engineers, which are told in state of art, still exist. Second question is if there are approaches on company levels to overcome these hindering factors e.g. through special programs and how these measures are evaluated by its target group. And third answer to be found is the possibility how the current professional engineering culture has to and can be changed to create successfully a more women and employee friendly working atmosphere.

The hypothesis is that if women engineers feel comfortable with the organisational culture of their company they do not feel marginalized and the tendency to quit their jobs will be less.

A main hypothesis is that it is necessary to change organisational structures to create a more inclusive feeling with content, form and culture of working.

A further hypothesis is that in the long run only a complex changing assessment which combines different proved single measures will succeed. At the same time global societal conditions have to be taken in account which show how various organisational arrangements lead to more or less success.

2 Collecting and Analyzing Data

One task of work package 4 has been to gather and analyse the organisational culture in the educational and professional sphere to get further information see D7 (Sagebiel, Hoeborn & Dahmen 2004), D8 (Sagebiel, Hoeborn & Dahmen 2004) and Draft D16/17 (Hoeborn 2005).

All data concerning professional sphere was gathered by qualitative investigations.

All partners of the project participated in this question which offers a great number of data on one hand, and on the other hand started a methodological discussion.

2.1 Sampling

All qualitative investigations had been done in two companies per country, in an energy company and in a non energy company. One of the companies should be chosen as an example of good practice in the assumption to lead to recommendations for other companies. The definition of good practice has been quite wide spread: women at all levels in all sectors of the company (no glass ceiling), women do not quit, higher amount of women than the national average ("than expected"), low hierarchy, women-friendly policy, family-friendly policy, flexibility for work-life-balance, women in engineering-activities, support for women in maternity leave and support for men in paternity leave, part-time jobs link to career possibilities, child care facilities, gender issues in social report.

Of course not all of those indicators can be found, and the term 'good practice' must be also seen in national contexts and circumstances, for instance both German companies have installed diversity programs and initiatives to recruit more women engineers, the Austrian good practice company has none of both, but in comparison to other Austrian companies the good practice company supports women engineers.

2.2 Field Work

The field work had been done by qualitative interviews. Two kinds of qualitative investigations had been carried out: single individual interviews and focus group discussions.

Women engineer managers and women engineers who quit had been interviewed.

In interviews with women engineer managers individual closely experiences in professional sphere were the main focus of investigation connected with biographical backgrounds. In comparison to the focus group discussions where the main aim was to get a diversified impression from women engineers' experiences and expectations in a company.

Supplementary semi-structured interviews with human resources managers and work council members were held to get information on needs and demands of women engineers out of the company's view internal career policies and employee promoting programmes had been asked for.

The data collection offers the opportunity and possibility to do national and cross cultural comparisons at the same time.

Out of organisational reason it had not been possible to carry out all the requested investigations, but most of them.

The interviewed managers are members of the lower and middle level of management. It has not been possible to find women engineers at the top management.

Women engineers who currently do not work in their former engineering professions were an additional focus of interest. The aim was to gain a deeper understanding of reasons for not retaining by interviewing those women engineers and to find out if company internal or external reasons forced the decision to leave. The women engineers who quit were interviewed out of the criteria of women engineers who quit and stopped working for family and personal reasons, one who was forced to quit because she was dismissed from employment and never found a new job, one who created her own company, and one woman engineer who quit to become a teacher.

Table 1 shows the previous determined sample for each company which should have been realized by all project partner countries concerning interviews and focus group discussions. Additionally investigations had been asked for see Draft D16/17 (Hoeborn 2005).

Table 1: Requested Investigations for Professional Sphere per Country

Company NE – Non-Energy	**Company E – Energy**
1 focus group with female engineers (FGEX_P)	1 focus group with female engineers (FGEX_E)
1 qualitative interview with the head of the work council (IWCM_P)	1 qualitative interview with the head of the work council (IWCM_E)
1 qualitative interview with the HR manager (IWHR_P)	1 qualitative interview with the HR manager (IWHR_E)
2 qualitative interviews with women engineers managers (IWEM_P)	2 qualitative interviews with women engineers managers (IWEM_E)
4 qualitative interviews with female engineers who quit (IWEQ)	
1 confrontation focus group (voluntary – FGCO)	

The letters in brackets give the signs where the complete interviews can be found on the webpage of the WomEng project.

2.3 Methodological Remarks

The interview guidelines had been developed by all partners.

Each partner had chosen the companies by national reasons, but nearly all the company are global players. Nevertheless the number of women engineer managers differs a lot, and the organisational culture as well.

The partners carried out their interviews and did a raw analysis including national specific comments. The partners did a national report summarizing the main results. The cross cultural comparison was done by the German team.

The overall agreement of the WomEng team on the interviews to be carried out was clearly formulated. It turned out that in some countries the methodology could not be verified caused by different reasons which could not be solved by the partners. For example having a low number of women engineer managers requests doing single and focus group interviews with the same women.

Therefore the level of interviews is quite different concerning to the interviewees. The definition of a manager seems to vary through the countries, the ages of the women engineers and their positions and experiences differ a lot, and the process of becoming a full engineer offers a big difference, because in some countries engineers need to be chartered, and in most of the partner countries they do not need yet, even if this process is going to change.

The interviews carried out have to be split into a group of young women engineers and into a second group of well versed and experienced women engineers, those are the two sides of the coin. So, even if the interpretation is based on individual interviews, which should be interviews with women engineering managers, it has to be strictly concerned to the age, position and experience of the women engineers. The same differences turned out in the focus group discussions. The cross cultural comparison has shown that over all partner countries these differences have been admitted. And this is the limit of the cross cultural comparison as well, because it is not always possible to compare the interviews caused by different samples.

Doing an interview does not only need the guidelines and the structure, it is also necessary to understand the 'language' of the interviewee. Sometimes women engineers have their own language including contexts and connections not being obviously for non engineers. A lot of comments have to be read between the lines, they are not told directly. This kind of interpretation of data may include misunderstandings, too. I noticed this in the German team having totally different interpretations done by a social scientist and by an engineer. This problem of having an 'own language' goes through all disciplines and all countries.

3 Cross Cultural Comparison Results and Interpretation

This paper gives a view on a part of the results and just to the cross cultural comparison results, the totally results per country are given in the Draft D16/17 (Hoeborn 2005). The fields reported on are the interdependence between private and professional biography, the organisational culture itself, and personal judgements and opinions.

3.1 Interdependence between Private and Professional Biography

A main difference in professional sphere between the European partners is the chartering of engineers. In some partner nations engineers need to be chartered to work as fully accepted engineers. This process of being chartered needs some years of work as an engineer and the reference of a company. In the UK engineers have to be chartered.

The reality in all countries shows that women engineers do career and get children at the same time, if they want this dual career. But it is important to see that those women are no role models, they are not known by their younger colleagues or by all the superiors. In public the interdependence between getting children and career break still is a persistent prejudice. France seems to be an exception because of excellent childcare facilities and less social pressure for women stopping their career when getting children.

The interdependence between getting children and career break is not obviously concerning to women engineering managers. Of courses there exist small restriction concerning mobility, but they are solved by the managers themselves. Women engineer managers earn a quite high salary and they organize private childcare like having a nurse or an au-pair-girl.

The women engineers who quit, which is an astonishing small group over all European partner countries, sometimes do this out of family reasons. But those women have not been in management positions at all.

Especially in Austria and the U.K. women engineers think it being a career hindering factor that superiors and colleagues assume that all women want to have children, it is a career hindering prejudice. And this prejudice causes the lost of support or more support for men.

3.2 Work-Life-Balance

Work-life-balance is mainly determined by career, overtimes, children, and gendered role distribution in private sphere.

The women engineers in all countries do obviously not have the common career definition and importance than men do. They are interested in work content, including widening their horizon by doing a horizontal career path, and in the working atmosphere, especially in Germany.

Children are still a point of discussion concerning their influence on career and work-life-balance. Childcare facilities are overall very good in the European partner countries, even if differences are obviously. The women themselves want to live their own work-life-balance including the time spending with their children and families. The younger and less experienced (German) women still fear a career break when having children and looking for a work-life-balance. They have their main focus on the compatibility of family and career even if they see family as a task for both partners. The women managers having experiences know about the difficulties but found their personal way to organize compatibility. Women in Germany, Austria, Slovakia, France and Finland do not drop out when having children, this turned out as a prejudice. They have additionally the possibility of part time working in most European states.

Part time working does unfortunately not have the same standing all over Europe. In some countries like Germany, Austria, France and Finland part time working is quite normal and accepted and offered at all companies especially for women having children, and a lot of parents mostly women work part time. But at other countries it is offered rarely like in the U.K. and in Slovakia, this is a career hindering factor.

Concerning the working hours and doing overtimes there is a big cultural difference between Germany, France, Slovakia and Austria and in the U.K., being quite normal to do overtimes and show an all time availability, showing a male dominated work culture, and Finland, where it is the other way round, doing overtimes, being a workaholic is not socially desirable at all. Nevertheless overtimes do not seem to be a big problem for women engineer managers being in the position where requested, just for the Austrian women. But on the other hand for young women engineers the fear of the pressure doing overtimes when having a management position is very high especially in Germany.

Gendered role distribution in private sphere in Finland, France and partly in Germany and Slovakia it is quite usual to share household and childcare, but traditional role models are still lived, too, and women being the breadwinners appeared as well.

3.3 Organisational Culture

None of the women engineers in Europe have had any problem concerning the transition from study to professional sphere. In Germany and Finland most of the women already have worked with the companies as student workers. In France the women engineers even have such a high status and prestige that they may choose their future companies by their own criteria.

3.3.1 Masculinity and Minority

None of the women engineers have had any problems at work as they told us. But women all over Europe– exceptions in Slovakia – are aware of gender differences, masculinity and their own minority situation. The Austrian women still feel as a minority being dominated by masculinity, and they told about the culture of sexist jokes. And the engineers who quit mentioned masculinity and minority situation of women being one main reason for dropping out especially in France and Germany.

The women told about masculinity and not having problems themselves at the same time all over Europe. This seems to be a contradiction having two possible explanations: First the awareness of masculinity is confirmed, but masculinity is really not a problem. Or second women engineers must not have problems caused by their tough image as it is told in former literature. None of the interviewed women engineer manager mentioned to be expected to be a tough woman at all. They have to be tough in the same way

than all academic women have to be. No difference between a social scientist and an engineer. Maybe this is one of the still remaining myths of women engineers being tougher than any other academics. This prejudice was not confirmed by any woman all over Europe.

3.3.2 Coping strategies and Leadership Concepts

The coping strategies of women engineers seem to be quite different, but a comparison is difficult caused by different ages and positions of interviewees. In Germany and France the coping strategies of women obviously depend on their professional experiences. Younger women try to find compromise way by partly accepting male rules but not buckling too much. The well versed managers already found their own way of performance and leading competence which clearly differs from male strategies all over Europe. Just one woman in Germany and one in Finland told that they adopted male strategies for coping.

All German engineers are aware of the differences between male and female leadership concepts, and the younger engineers are deterred by the atmosphere at the management levels – missing role models.

All women engineers mentioned the importance of the social skills like manners, politeness, listening to each other, caring for each other being a part of the gendered leadership concept, even if some women managers think that ale colleagues partly have these skills, too. In France there seem to be partly socially desirable answers telling no differences for equality. It seems quite obviously that some of the Slovak women engineers do not have any gender awareness yet, they notice differences but they feel the connotations are negative.

3.3.3 Work Satisfaction

Women engineers in all European partner nations seem to be really very satisfied by their jobs. They see and feel the great pressure they get by this dual career when having children, but it is positive for them.

All women engineers in Europe like their current working atmosphere and they determined the importance of a good working atmosphere. All women think that the working atmosphere is linked to people, meaning employees, colleagues and superiors. Trough all the qualitative interviews the spirit of the women and their satisfaction by mentioning gender awareness at the same time is obviously. The women seem to be really a part of the engineering world. Their male colleagues seem to be pleased to have women engineer partners and the women really seem to like their work content and their working atmosphere.

The women in Germany and the UK determined that a genderedness of importance of work content and working atmosphere exists and influences career. But on the other hand a change is going on, men in both countries give a priority to work contents and working atmosphere, too.

3.3.4 Networks

The understanding of women networks is split into two components one concerning private and on concerning professional sphere. Professional sphere is related to having a formal women's network. The informal network like men have has nowhere been the point of discussion. All women are aware of the male networks. And except Finland they are all aware of the big power of old boys' network concerning their careers, and that they do not have fully access to it. All women know that this is one reason not having more women engineers in higher positions. Again the French women do not want to face the

problems of not having access to the network. The culture in Finland does not seem to be in that same way, too, the finish women admit that male networking does not cause any disadvantages for women.

3.3.5 Summary

To give a short summary on the important points concerning organisational culture: All companies have their own specific cultures. The companies being good practice seem to have the focus on the social competences and creativity of employees. Diversity, including the acceptance and valuing of gender differences, has been an item in all good practice companies and seems to support women's career.

The professional sphere concerning the equality between men and women is like a mirror of the social culture in Finland. Responsibilities and tasks concerning household and childcare are shared, women are treated equally than men, overtimes are not socially desirable. In comparison to the European partner nations it seems to be a women and family supporting culture.

The awareness of gender differences is notified at all partner nations, but the women do not always try to use them in a positive career supporting way. Living diversity, which includes living gender differences, supports women all over Europe being confirmed by good practice samples.

The pictures of women engineers are very bride and without real problems as the women painted them themselves, life being a positive challenge. Concerning to former social scientific literature this painting is a socially desirable art. Contradictory to the literature the women all over Europe told about their satisfactions concerning work content and work atmosphere. They told that the engineering world has changed, women found their positions and their gendered way of filling the positions. Nearly all of the women are aware of the gender differences connoted positive and they are aware of the possibilities caused by gender differences. The women know and feel that gender differences include positive resources which support women.

3.3.6 Personal Judgement and Opinions

A view to change the future: The women engineers have three main points of being hindering their career and being responsible for not having more top managers.

The first is their priority of work/life/balance. Even if the women say it is a priority chosen by themselves this is of course just one side of the coin, the other side of the coin is the social and political pressure. In Germany, Austria, Greece and France as well as in many other countries the picture of a woman is as still the one having a good education, doing partly career, and taking care of her family.

The second main point is the male network. Career is still being done by education and by networks as well. Old boys' network is a career hindering factor in Germany, Austria, Greece and France. It could probably be assumed that in the U.K, and Slovakia it is the same way, even if not mentioned word by word. Just Finland admitted that the 'old boy's network' is not a hindering factor for women at all.

This hindering factor can not be changed by the women themselves.

The third main point the women engineers made was diversity, gender differences. Women are different than men, and their behaviour, performance and knowledge is valued in a different way. Diversity programs help to produce sensibility for gender items, too. The French women did not want to discuss topics concerning equal opportunity and gender differences out of socially desirable requests, but at some points discussions the awareness of those problems turned out.

Role models would be helpful for young engineers and would raise the public awareness.

Greece mentioned that childcare possibilities have to be widened. And there also exists a deficit of women concerning performance like vocal trainings.

4 Conclusions

Women managers combining family, career and work-life-balance should participate in programs as role models to show the broad field of possibilities to find the own way of life priorities.

A further personal training concerning career planning and career paths should be installed and organized by non company employees.

Young students should be told to take student jobs at big companies to get used to working atmosphere and also to become a part of the company network.

Networking should be a point of interest Students should be aware of the networks and the way they work. Women engineering managers should tell the students about networking.

A further personal training concerning networks should be installed for women and men.

A women engineer should be in each team because she can make a difference to the culture.

To overcome historically grown patterns and resistances, a broad variety of programs at all levels of education and professional sphere is needed in some countries.

More experience abroad will widen the horizon. The European Union with its mobility programs on various levels offers many opportunities for more cross-cultural and cross-national exchange and life long learning, not only for students during their university years but also later on in their careers. Men and women will get experiences in countries having a more women supporting culture.

Furthermore, gender sensitivity trainings should become a standard modul in further training programs, for both men and women. Being a woman not automatically leads to gender awareness and sensitivity or to behaviour that fosters equal opportunities and reduces or abandons discriminatory structures or patterns.

For all those activities it is vital to reach the support of and co-operation with gender-sensitive men on all hierarchical levels.

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Human Resource Development in the area of Engineering in Slovakia

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Abstract

The people are the most valuable source of prosperity for the employers. The well-educated and motivated staff should be the highest value in the company, regional community or country. Does it really work in practice? What is the current situation in the engineering education, demand, structural and curricula changes? How the universities solved the problem of the transition from centrally planned economy to the market economy?

The paper studies the interdisciplinarity phenomenon of the engineering study and its influence on female proportion in engineering studies and deals with some aspects of the human resource development for engineering career starting from the university and going through professional life with special focus on gender aspects in Slovakia. Also a comparison with other countries of European Union is realised in that respect. The recommendations for the further improvements in the above-mentioned area are included as well.

Introduction

Similarly to other countries in transition from centrally planned economy to market economy, former Czechoslovakia reflected after the political changes in 1989 the necessity of renewal of the educational and training system The political-societal and social-economic changes, which took place in Slovakia have logically resulted also in fundamental changes in the field of education and training, and its management as well.

The transition process started substantial changes in their educational systems and still it is not yet brought to a conclusion. Slovak Republic might accommodate in that respect as an example representing Central European countries as Poland, Czech Republic and Hungary, although there exist various distinctions among them. New acts changed the mission and position of higher education institutions, and unambiguously specified their self-governing status, fundamental academic rights and freedoms, the right to freely elect their self-governing bodies, etc.

Historically, in the most of centrally planned economies, women's labour market participation was high and gender pay gaps low in comparison to many Western economies [1]. Employment policies in Eastern Europe were based on a belief in both the duty and the right of women to work. In the former Soviet Union (and similarly in the centrally planned economies of Central and Eastern Europe), female participation rates were regularly over 70%, while in the West, the rates as high as this have only been

observed recently in some Scandinavian countries. A noteworthy fact is that in the current transition period the participation of women in the labour market has dropped in most of the transitional economies, including Slovakia (74.2 % in 1990, 62.6 in 1999 – ILO, Bureau of Statistics).

To understand the position of women in the labour market and educational process, some important historical inquiries should be mentioned. During fiftieth and sixtieth of the 20th century Slovakia still has been characterized as an agricultural country along with the start of massive industrialization. The character of the economy has quickly changed over the years and agriculture is almost marginal sector nowadays, with less than 8% rate of employment. Industrialization and official state policy of gender equality changed naturally the job participation of women and men according to sectors.

Development in the Engineering Education in Comparison to the other Fields

The official policy of supporting women to study engineering in fifties and sixties of the last century dramatically increased the number female engineers in the country. Here is the real reason that influenced the current situation. After the year 1989, opening of educational market has led to increasing demand in study of business and social sciences, influencing both females and males. Since than, there is a substantial contrast between men and women as far as the acquired education is concerned.

Opening educational market, waive of engineering courses support and protection, together with decline of industry has recalled lack of interest in engineering studies. Decreasing demand for engineering studies and following cut in quality of students caused that technical higher education institutions started to humanize engineering studies by introducing interdisciplinarity as a main tool to keep the same number of students. The former Marxism – Leninism courses have been replaced by courses like languages, sociology, psychology, law, ethics etc.

While more than 50% of female students in Slovakia are following so-called "women-professions" such as social sciences and humanities, economics and business administration, pedagogy, etc., naturally results in much smaller percent deciding for studies in engineering. Following statistics in last 5 years, there is approx. 30% of female students engineering, while in electrical engineering the share is following European numbers – 4%. The most popular faculties at the present time are those offering Economics and Business Administration courses – 57% female students.[1]

It is worth to mention that in the Slovak faculties, the universities consist of faculties, being until recently legal bodies with rather high competencies. Informally, their influence and autonomy is still powerful.

Hence, the distribution of the higher education institutions is the following:

- University type, which concentrates on theological education, natural sciences, medicine, pharmacy, veterinary medicine, humanities, arts, philology, law and education
- Technology type, which concentrates on mechanical engineering, electrical engineering and informatics, production technologies, metallurgy and civil engineering, transport and communications
- Economics type, which concentrates on economics and business administration
- Agriculture type, with concentrates on agriculture and forestry sciences

[1] Statistical Office of the Slovak Republic

- Arts type, which concentrates on performing arts, fine art and design, drama, music and dance, film and television
- Military and police type, which concentrates on military and security sciences

Educational sphere is still in growth according to number of student and also number of HEI and its faculties. The following table illustrates the development of the number of HEI and its faculties in the last 5 years.

Table 1: The number of HEI and its faculties

Number of bodies	2000	2001	2002	2003	2004	2005
Higher Education Institutions	23	23	24	25	27	28
Public	18	18	19	19	20	20
State	3	3	4	4	3	3
Private	2	2	1	2	4	5
Faculties – type of	96	96	103	107	113	114
University	40	40	46	49	55	55
Technology	18	18	19	20	21	21
Economics	16	16	16	16	19	20
Agriculture	7	7	7	8	8	8
Arts	8	8	8	8	8	8
Military and Police	7	7	6	6	2	2

Although the number of technology oriented faculties slightly increased the number with the most important indicator describing the situation in the engineering education is the following:

Table 2: The proportion of technology students

Year	Proportion of technology students
1989	45.3
1993	35.9
2004	13.9

The following table describes the recent trends in all the fields of study in the Slovak Republic.

Table 3: Number of full-time students in public higher education institutions in 2000 – 2004 by the field of study.

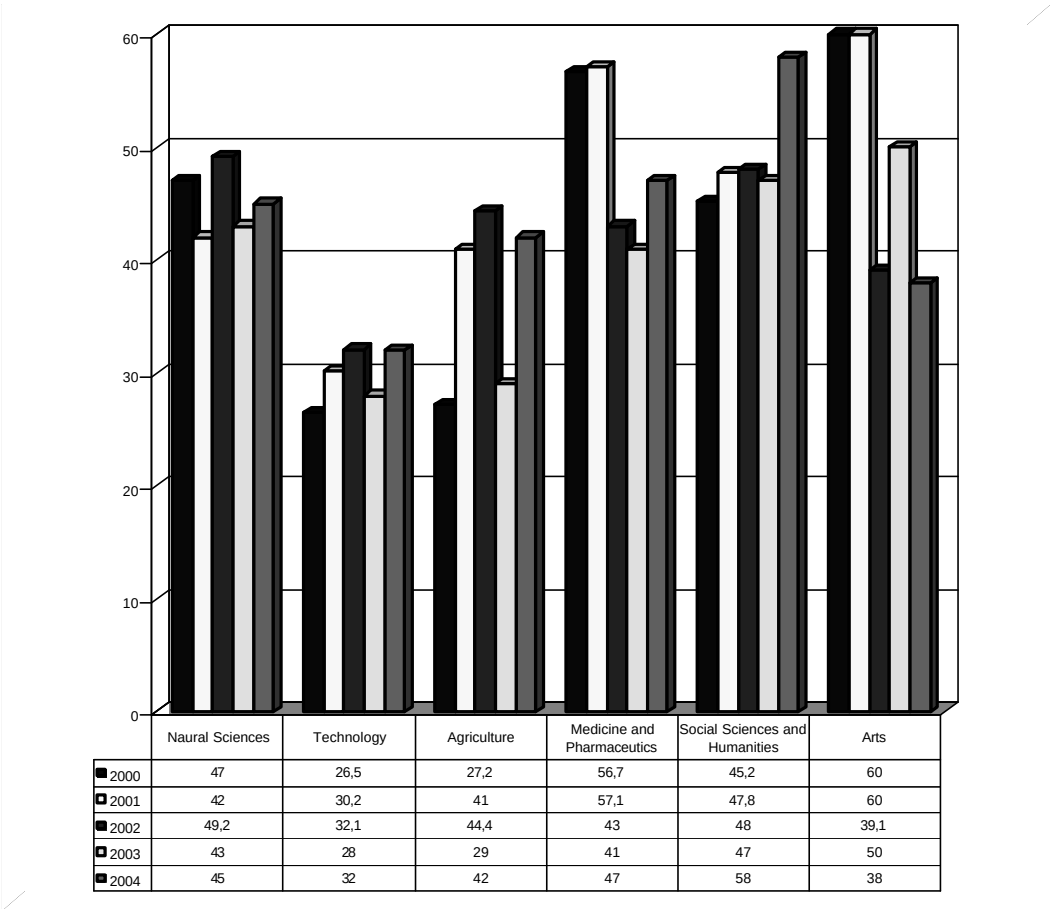
Field of Study	2000	Rate of change	2001	Rate of change	2002	Rate of change	2003	Rate of change	2004	Rate of change
Natural sciences	1 437	1 043	1 168	181	1 475	-143	2 047	572	1 177	-870

Technology	5 133	2 016	5 846	713	6 958	1 112	8 139	1 181	7 004	-1 135
Agriculture	2 237	226	2 725	488	2 728	3	3 098	370	2 836	-262
Medicine and Pharmaceutics	1 205	768	1 368	163	1 911	543	3 891	1 980	3 667	-224
Humanities and Social Sciences	27 993	4 912	32 761	4 768	31 317	-1 444	33 683	2 365	34 566	884
Arts	374	306	656	282	656	0	673	17	266	-407
Military and Police sciences	214	82	0	0	460	0	584	124	851	267
Total	38 593	8 353	44 974	6 595	45 505	71	52 114	6 609	50 367	-1 747

Source: Statistical Yearbooks of Education SR (1999, 2000 2001 2002 2003 2004)

What is still positive in the engineering study development according to "dramatic losses" in the last period, both absolute and relative, is the percentage of female students remaining almost same. The percentage is lower when comparing the other – more attractive fields of study, but about 30 percent of females is a very good result in the light of the development in the last 15 years in the country.

Chart 1: The percentage of women according to type of faculties



	Naural Sciences	Technology	Agriculture	Medicine and Pharmaceutics	Social Sciences and Humanities	Arts
2000	47	26,5	27,2	56,7	45,2	60
2001	42	30,2	41	57,1	47,8	60
2002	49,2	32,1	44,4	43	48	39,1
2003	43	28	29	41	47	50
2004	45	32	42	47	58	38

What are the main factors influencing number of engineering students and the females proportion in Slovak Republic?

First of all, the transition has abolished system of quotas determined by the former governments. That opened the chance for those having not a chance to admit study branches such as law, business administration, etc. and the engineering HEI have been confronted with the lack of interest in the engineering fields, decrease of interest, motivation and quality of their applicants. And the trend coming from the demand side (applicants, students) has been reinforced by the collapse of the former industry (heavy, special, mechanical), phenomenon of unemployment and firing technical staff and engineers. The reaction of the engineering faculties was very natural and similar – to survive bad times by up keeping the same numbers of students with a loss of the quality of their students on the other side and by offering more attractive (translate as interdisciplinary) study programmes.

The interdisciplinarity of engineering courses became a solution to attract the students as an important precondition has been fulfilled:

The engineering degree was very often only the second choice as a substitute for business administration, social sciences, humanities, law, etc.

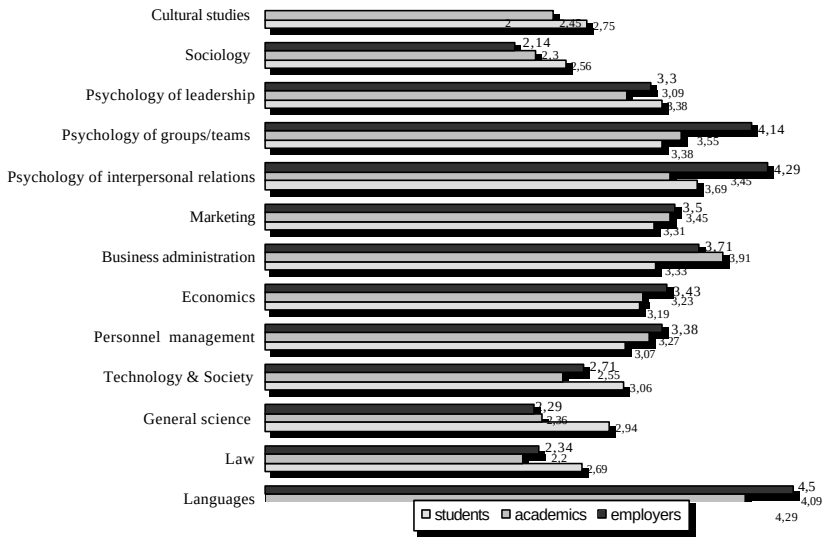
Interdisciplinary courses became a solution and successful mid-term strategy for the engineering faculties to keep up or not to loose former number of students. The interdisciplinary character of study has already been identified in the European project INDECS (Béraud [2], Sagebiel, Hoeborn [3]) as one of the key players in attracting women to engineering courses, although to distinguish and isolate this factor from some other factors, such as teaching methods, specific organisational structures (Sagebiel [4]) (ex. mono educational courses, tutoring etc. . . .) is not always possible. Moore and Holford [5] concluded that engineering education would be improved if programmes of study had far more practical examples.

INDECS is the acronym for a Fifth Framework Programme project "Potentials of Interdisciplinary Degree Courses in Engineering, Information Technology, Natural and Socio Economic Sciences in a Changing Society: Focus on the enhancement of women's entry, participation and progression. The project was set up in the context of identifying measures to increase the participation of women in Engineering, Science and Technology.

Structured questionnaire survey has been realised for three groups of respondents to be able to compare their opinions on questions dealing with interdisciplinarity courses strategy: academics, students, professional sphere – answers were received from female engineers. In the questionnaire respondents had indicated their answer by using a numerous scale (number 1 – not important, number 5 – very important).

The hypotheses about interdisciplinary courses and the differences among the three groups studied have been studied by asking several questions. According to hypothesis, interdisciplinary studies would help to recruit more women into engineering. All three groups find the study of languages as the most important to draw more women into engineering, i.e. 4,09 – 4,25. The other subjects of possible interest for females are considered psychology of interpersonal relations followed by Psychology of groups/teams and Business administration. There is a small gap between students and employers, employers are more optimistic in attracting women by non-engineering courses such as languages and psychology related courses.

Chart 2: Which interdisciplinary studies would specifically help to recruit more women into engineering?



The hypotheses tested in the INDECS project have been proved also in the project of the 5th EU-Framework Programme WomEng – Creating Cultures of Success for Women Engineers.

In the survey realised in the frame of the project a question dealing with the interest and motivation of engineering students has been tested and compared among the countries.

16. What are the reasons which made you decide to choose engineering: on a scale from 1 to 5 evaluate the importance of each reason(1= no importance ; 5= the highest importance)

a) Interest in the subject overall

b) Interest in Engineering

c) Interest in Physics

d) Interest in Mathematics

e) Interest in Computer Sciences

f) Interest in Chemistry

g) Interest in Draft and Design

h) Interest in Technology

i) Interest in Mechanics

j) Interest in Life Sciences

k) Interest in Environmental Sciences

The Slovak republic reached opposite results when comparing the other countries involved in the survey – France, Germany, United Kingdom, Austria, Greece and Finland. Students from Slovak Republic declared significantly lower general interest in Engineering, Computer Sciences and Technology. As the opposite, they are significantly more interested in Mathematics and Mechanics as the students from the other countries participated in the survey.

The answers underwrite the hypothesis, that in the Slovak Republic the study of Engineering is much often only a second choice for the students, not a first interest and at the same time the different image of

technology. Moreover, when choosing engineering study, they probably support the decision by a good knowledge of Mathematics and interest in Mechanics.

There is no significant difference when comparing Slovak males and females.

Quite interesting in this reflection are also answers of the Slovak students to the question:

39. Do you agree with these perceptions of engineering professional life? (1= strongly disagree ; 5= strongly agree)

Comparing the other countries involved in the project, the perception of engineering professional life is different in Slovak Republic They do not consider it as having a heavy workload and a problem with work/life balance, etc.

Conclusion

In the paper has been proved that the Slovak Republic, having different historical background disclosures differences mostly in the motivation for studying engineering and their perceptions of engineering professional life. At the same time, the effect of choosing engineering as the "second choice" has consequences causing those differences.

The movement to interdisciplinarity was a good step to keep up the number of engineering students in the Slovak Republic during the transition period from centrally planned economy to the market economy. Although, keeping the quantity has been accompanied by the loss in quality and partial turn-out from the classical engineering courses. The positive by-effect of that strategy and development concluded in keeping up the same percentage of female students as before the political and economic change.

During the first decade of the 21. century, when the industry is again in a better condition, the country is well prepared from the point of view of human resources, particularly female human resources. What is an interesting feature, Slovak engineering faculties did not have any women oriented recruiting or programmes, but the result from the gender point of view may be considered as satisfactory.

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Five years after … – are we on the right way?

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Abstract

With the summer-semester 2004 the first graduates of the women`s course in Business Administration and Engineering has left the university of Stralsund. The first of them have been found an employment before they finished their diploma-work. It seems that companies don`t have problems with the first and single women`s course in East Germany. The technical, economical and personal abilities of the applicants are for them most important and not the question if the women studied in technical courses without men.

This course started with 25 students in 2000 and enjoys since its existence of a constant demand and interest by the young women. To the present time 74 young women study in the women`s course.

The following contribution includes:

1. introductory remarks to the implementation of this women`s study course

2. some essential impressions of the students and of the lecturers and

3. results and an outlook

The implementation

The women`s course aims to connect Engineering with other sciences. The study contends technical courses, business management, social and ecological lectures and case studies. This model bases on an interdisciplinary starting point. This model of the university of Stralsund corresponds to a particular conception, that not yet tests in the other women`s courses. The difference makes that we didn`t copy the mixed course in Business Adminstration and Engineering.

It connects

- monoeducational courses and exercises in the technical subjects of study
- with coeducational elements in not-technical subjects.

The Monoeducation refers on the technical subjects of study as well as on the new kind of spezialisation "**communication – information – management"** in the study. The lectures in economical and social sciences were organized coeducational.

This division was chosen in order to avoid a social isolation of the students of the women`s course because it`s still discussed. Today the experience confirms this idea – it was nothing then a feeling in the past.

Interesting common solutions of problems in form of projects, seminar papers and houseworks, for example in political economics and business management, quickly results from the collaboration with students of the coeducational course of study. This team working contributed to the reduction of barriers and prejudices. No special roles were attributed to the women and in especially the male students became conscious that actually completely „normal women " with the same problems as they studied in this group.

The monoeducative transaction of all lectures in technical subjectsas well as in the experimental work in the laboratories formed an essential basis for this new course. The problem since starting has been the complet exploitation of the existing capacity of equipment and personnel.

Basic conditions of the implementation

This course in Engineering for 'women only' in the Stralsund university with priorities in technology, in the department of Mechanical Engineering – one of the hardest disciplines of Engineering – offered new chances, but it was connected however also with risks.

The chances were seen above all are

- to advance the frequently discussed reform of the study in Engineering forwards, when parts of the concept are taken into the coeducational curriculum too;
- to plan all kinds of innovative specialisation, which connects the inclinations, expectations and interests of young women with those of the economy in particular manner,
- to held open the Curriculum for changes and new ideas by the accompained quality management of education;
- to perfect the university as a gender equality organization –„fresh wind from direction of gender "– with support through various networks;
- to use the politycally and economically situation in 2000 – institutions of the guoverment aimed to increase the number of women in Engineering and higher positions of the economy. They were looking for new ideas and projects: for the first time in Germany women had the chance to study Engineering under changed conditions. But we were under a great pressure of succes because some peoble didn`t exspect that we could find women for such course of study without men.

The risks consisted of it that

- skepticism and many restrictions in factual and staff shaped and still shapes the women`s course of study ;
- new lectures which necessitates additional time and effort are interpreted hastily as preferences of women;
- the lacking presence of Gender-subjects in – and outside the university and the lacking sensitization impeds and hinders again and again the continuation of this project;
- the target group for this course will relatively restricted because the most students comes from the state Mecklenburg-Western Pomerania as well as from East Germany;
- relapses are fearing for a long time if the demand stays away;

- the competition about barely nascent finances and the reduction of personal ressources the practicability restricts to continue such new ideas.

Networks as well as within also as outside the university played an important role for the implementation of the women`s course. They supported an open and positively embossed discussion and publicized the course of study far over the borders of the state.

General characteristics of networks are the following:

- They aim on the realization of advantage in competions for the partners.
- They represent a kind of organizations for common activities over the borders of an single organization.
- They embody a form of the cooperative collaboration between partners which are member in different organizations (inter-organizational cooperation).
- They are narrow, but not rigidly connected systems in the comparison to hierarchical structures within organizations.
- They allow an organic connection of the kernel-areas of authority of the partners with the special case of the strategic network.

Networks also proved the suitable instrument of organization to advance new tasks in the organization, for which are no majorities within the university.

Some examples for networks which were used:

- the network of the female professors in the department of mechanical engineering and partners form the other departments at the university;
- the team of the project "Frauenstudiengang";
- the different networks of femalee entrepreneurs in the region;
- the network with local representatives of gender equality as well as the „rounds tables “and further regional networks;
- Network of the representatives for gender equality of all universities of Mecklenburg-Western Pomerania and the network of the conference of the women – and equality-representatives of all universities in Germany;
- national networks of the club of German engineers (VDI), the society of German academics (GDA) as well as the society women in the management.

These networks and connections between the networks were significant, but just as temporary partnerships. They have adopted an important support in the first years of implementation. It necessitates a high expenditure at time and energy however in order to uphold the cooperation permanently. Therefore, the networks are knotted meanwhile more loosely and the contacts are more rare. However they become activate from the one or other side again as soon as demand exists.

Fundamental construction of the Curriculum in the women`s course

The women`s course represents an innovative offer for female students. Not only abilities are arranged in economy and technology but additionally also the necessary social competence for the engineers in their specific work. The fundamental construction of the Curriculums became like follows shaped:

- The Curriculum of the basical study in Business administration and Engineering was changed only unimportantly. The students of the coeducational course can change through it into the monoeducational course of study (and turned back).

- The women`s course is a mix of monoeducational learning (in technical subjects and practices in laboratory) and coeducational learning (in not technical subjects).
- Particular value was attached to the subject competence in economical and technical subjects and on active forms of teaching and learning.
- The boundary between technical and economical "knowledge in depht" and practical abilities has been clarified. That was necessary because the number of the hours is restricted per semester. It was necessarily to be entered compromises and nevertheless to mediate a sufficient knowledge in each subject.
- Investigation concerning Quality management has allowed to control whether the expectations and interests of the students are actually lived up. The Curriculum was designed open and ready for changing in order to correct deviations. The aim of the accompanied research was to derive positive impulses for a change of the coeducative course of study.

Methods of investigation concerning the Quality Management

Qualitative and quantitative methods of the social research were put in as instruments of research.

Following methods of investigation about the quality-management were used:

- personal conversations and group-discussions with all teachers over their impressions and experiences,
- guided interviews of the teaching persons based on a structured paper,
- interviews of the students based on a standardized questionnaire,
- personal meetings and group-discussions of the project-leader with the students.

The first questionnaire for the students to beginning of their study was divided into three parts

Part A: Previous educational – and occupational way

Part B: Reasons for the election of the course of study, expectations at the study, the subject, the curriculum, teaching methods and the behavior of teaching persons

Part C: Personal data and prerequisites as well as intent to the further career.

After the students had completed their practical semester in companies, they were questioned in a second questionnaire to the fulfillment of their expectations at the study and the subject and at the curriculum, the teaching methods and the behavior of the teaching persons.

I would like to try in the following to introduce the results of the research shortly, in that I return and expound

- some impressions of the students and

- some impressions of the teaching personnel.

Impressions of the students

No one of the students wanted to become an engineer originally. As original wishes to study, they named psychology, pedagogy and economics.

The natural sciences (besides biology) not belonged their favorite subjects in the school. The most important criterion for the decision to become an engineer was not the possibility to study only with women in a group. The new, interesting main focus in Engineerings: Communication – Information – Managment was the reason, because it comprised more than only technology. The decision for the study

in Business administration and Engineering was promoted also the accompanied quality-management and the outlook to study in a small group in an open learning and teaching atmosphere.

The main expectations at the study was reached in the eyes of the students in high measurement:

- the connection of technical and economical knowledge –100%
- the topicality of the knowledge –96,5%
- the multidisciplinary knowledge –94,1%

One of the expectations at a women`s course was the studying with women in a community with more near social solidarity. A special treatment or lacking competition with the study among women, both frequent arguments of the opponents of special women`s courses, was not expected and not watched by the students.

It attracts attention that the preference was given the passive forms of teaching and learning to beginning of the study. The teaching persons should support the students with study-accompanied scripts, practices and examples. Personal solution of case studies and presentation of its results shunt far behind teamwork and role-playings as preferred forms of teaching. This opinion is changing while their study – a clear turn to the active learning forms emerges.

The behavior opposite the students in the women`s course of the co-workers, technical personnel and laboratory-engineers has been essentially better assessed than the professors

The behavior of the professors appears to the students interested (70%) and they assessed it as friendly.

82,0% of the students would make the decision to come to the university of Stralsund again.

If one compares the statements to the reasons of the decision for the Stralsund university after the practical semester with the statements to the beginning, attracts, that the the town and the evironement, the reputation and tradition of the university as well as the favorable infrastructural connections increase in importance.

The subject of their study remains the most important reason also after the practical semester to choose the university of Stralsund. Approximately, 70,0% would choose this subject again.

The learning in technical courses without men, the experiments in labs without men and the experience with discrimination of women have won at importance while study.

While 18,2% of the students declared the discrimination of women to beginning of their study as important reason to choose the women`s course, it has been 38,50% after the finish of the pratical semester. This result suggests the supposition that the women during their study must have done own experiences with discrimination and dissimilarity of gender (compares the statements about the behavior of the professors). But in contrast only 15,4% (18,1% in the start of their study) of the students is interested in topics about gender.

It appears disappointing on the first view that only 15% would choose the women`s course again. Looking at the reasons of the decision for the women`s course the students name exactly the reasons, which mark the peculiarity and uniqueness of the women`s course.

Enforced interviews and discussions with the students have assumed that the daily contact with technology, technical equipment and the successes in the study of the technical topics during the study, notably after the practical semester, reaches the opinion, that they would have finished also a successful study in the coeducational course.

This supposition can be substantiated because 31,8% of the students thought about a change of the course of study after the first Semesters – after the third semester it was only 4,5%.

On the question after the reasons, why they would not choose the women`s course again, the students answered

- predjudices through professors, other students and many other persons,
- reproaches of a special-treatment and an easier study in the women`s course,
- conflicts in the study-group and
- too much and hard competition in the women`s course.

Impressions of the teaching personnel

Respecting their attitude to the women`s course three groups crystallized out:

Group 1: continuously positive attitude to the women`s course

Group 2: changes the attitude from waits for, hesitant, not skeptically however adversely to mainly positive

Group 3: durably or increasingly refusing until hostile, that is often shown frankly.

The second group involves over all professors in the technical areas of study. They have changed their opinion, because they have seen the female students as hard-working and ambitious women which wished to understand totally technical problems and didn't hesitate to ask all questions. Teaching persons in this group have partially only recognized during the lectures that they must get ready differently for the female listeners and cannot apply simply abstract, technical examples in order to expound contexts.

The third group (so far possible) did not lectures in the women`s course – teaching personnel with refused attitude have been replaced.

The absence of a steering authority, that prevents a change in group three or makes possible the change from three in two, represents a organizational problem. The fact is remarkable that all teachers of the women`s course lamented the lack of a further education in a gendered didactics or a better preparation.

Results and outlook

In the organization " university " has gotten everything in movement and important alterations begin to emerge:

- Monoeducation is finally perceived as an additional option of the study.
- The students demand quality and enliven the discussion about the quality in the education.
- The differences between women and men are perceived and to a topic in the conversations and discussions.
- The connection of women and technology is establishde as goal in the corporate identity model of the university.
- Networks still remains important for the conservation of the study, but they must be enlivened again and again. They could lose the influence if they are not positioned durably and independently from the change of single persons. Majorities for this kind of study have not yet turned in Germany into the normal case.

New danger threatens through the ' homo oeconomicus': He makes the efficiency which can reached in a short time for the goal of thinking at the universities. The increasing shortage of staff and financial resources under the title ' Bologna Prozess' leads to the reduction or deletion of sujects until the closing of courses in studies.

The German politics is responsible that the changes of the 'Bologna process' are used in order to lead back the reform of Engineering. Important advances, as for example the reception of economical and social contents, is put in question in order to shorten the time of study. Scarce resources toss up the question constantly: Can we really afford this special course for women only? It is not heeded that 75 women could be empowered additionally for Engineering or that many companies praise the knowledge and abilities of our graduates of the womens course.

Women`s courses have not turned *into the normality* just long ago. Women`s courses has been established under political pressure. Without a organizational development process universities will be put to the disposition such innovative kinds of study again and again. Universities need a guided learning process to reach such change. In this field appears a difference between the academic discussion and the economy, which ask qualified engineers independently from their kind of study.

Three conclusions appear to me significantly:

, 1, It doesn't give the one and right way in order to fill more women for the occupation of the engineer or a technical study with enthusiasm. It is important that many different offers exist side by side.

, 2, we must plan on a longer time period, in which women and technology approach one on top of the other. Universities on the second level of the educational system are with their initiatives only one medium in a whole bundle of measures. As well, kindergartens and schools and further education-institutes must achieve their particular contribution in order to encourage women for technical subjects.

, 3, we have to do it with a social problem: As long as women in their occupation on the labour market do not receive completely equal share in all areas, for example payment, leadership-positions among others, so long technology will stay "second election " for them and they will behave accordingly.

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Comparing Grapefruits and Tangerines: a Fruitful Experience

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Abstract

The methodology developed by the WOMENG consortium represents a major output of the project, which could be transferred to other projects in social and gender studies.

Methodology for the WOMENG project had to deal with at least four challenges: first with historically and socially constructed concepts as gender and engineering, second, with cross-national comparison assumed as a research strategy, third with the collection and combination of different sets of data, gathered through different approaches, fourth with a large-scale research programme generating tons of data. In addition, as the WOMENG project was interdisciplinary and intercultural; this situation implied both translation and methodological problems.

Through research experience, a methodological toolbox emerged from the WOMENG project. Four steps have been identified and described: designing research, doing fieldwork, reporting, analysing and interpreting. This paper presents an overview of those steps. It seems crucial to keep in mind that those steps are connected, and that only collegial process can ensure comparability. Through that common work are emerging similar categories, similar configurations that allow new hypotheses, but don't deny the diversity of each specific setting.

From a methodological point of view WOMENG results illustrate how an iterative cross-cultural mixed methodology allows a fruitful comparisons that goes far beyond the usual statistical comparisons, with the limits it implies: never forget you compare grapefruits with tangerines. Anyway, further research in methodology for cross-national comparisons remains necessary: If the methodology for research design, fieldwork and reporting may be considered as rather well documented, which ensures comparability and commensurability, the methodology for browsing the data still lacks efficient technical tools, and the methodology for qualitative comparative analysis needs further research. Further research on those topics would open new perspectives for large scale cross comparative social research.

Introduction

The methodology developed by the WOMENG consortium represents a major output of the project, which could be transferred to other projects in social and gender studies. This paper presents the methodological toolbox developed by the WOMENG consortium, combining qualitative and quantitative

methodology. This toolbox is presented thoroughly in a specific publication (Pourrat 2005) and will be available on the project website www.womeng.net from November 2005.

From the beginning, comparison as a research strategy was decided, assuming that a comparative approach will bring more than national results and will represent an opportunity to reveal new hypotheses, as expressed for example by Lallement and Spurk (Lallement and Spurk 2003).

Methodology for the WOMENG project had to deal with at least four challenges: first with historically and socially constructed concepts as gender and engineering, second, with cross-national comparison assumed as a research strategy, third with the collection and combination of different sets of data, gathered through different approaches, fourth with a large-scale research programme generating tons of data. In addition, as the WOMENG project was interdisciplinary and intercultural; this situation implied both methodological and practical problems that must not be underestimated.

This paper presents in a first part all the methodological challenges faced by the WOMENG project, and in a second part, the practical problems encountered during the project and the solutions to solve or avoid them, and in a last part the toolbox that has emerged from the research experience. Four steps are identified and described: designing research, doing fieldwork, reporting, analysing and interpreting. Through common work have emerged similar categories, similar configurations that allow new hypotheses, but don't deny the diversity of each specific setting.

Methodological challenges

Gender and engineering

Gender and engineering are two historically and socially constructed concepts, with differences and similarities from a country to another. Furthermore, masculinities and feminities interact everywhere in their own original ways with engineering. Anyway, first of all, a cross-comparative research project has to ensure comparability through the definition of common research objects, common classifications, and common scales of evaluation.

Gender categories don't work the same way everywhere in Europe, even if, statistically speaking, women are easily identified in gendered statistical data. Difficulties occur there during interpretation. We explain below how we have coped with cultural diversity through reporting, analysis and interpretation.

"Engineer" represents another type of methodological difficulty. "Engineer" appears as a fuzzy object meaning various levels of qualifications and various areas of expertise across Europe. The WOMENG project decided to concentrate on the common characteristics of engineering in all countries. "Engineer" is defined here as an academic degree confirmed by an accreditation board, at master level, in all scientific and technical areas, excluding agronomy, business and architecture, which are not considered as engineering disciplines in all European countries. As far as possible, existing international classification ISCED and ISCO[1] were used to allow use of existing data and further comparisons. In the quantitative questionnaires, approval and disapproval were measured on a scale of 5, "1" means "strongly disagree"

[1] ISCED is "International Standard Classification of Education" (1997 – UNESCO) and ISCO is "International Standard Classification of Occupations"(1988, used by EUROSTAT).

and "5" means "strongly agree". Ambiguous translations and cultural variations were tracked down by collaborative work of all partners.

Because engineering is a very diverse field, the sampling needs also to take into account the various areas of speciality and the ranking of the diverse faculties and schools[2]. In the professional sphere, three criteria were selected for an exploratory study of two companies in each country. The sampling includes at least one company in the energy sector[3], one with "good practice" to attract and retain women engineers, and, if possible, one in the manufacturing sector.

Research teams from seven different European countries constitute the WOMENG consortium: France, Germany, Austria, United Kingdom, Slovakia, Finland, and Greece. Even if the participating countries differ by the size of their population, the same number of questionnaires was handed out in all countries. The sampling philosophy was based on three assumptions: 1) to compare women and men situations, the same methodology and sampling need to be used, 2) to get more information, the sampling has to be larger where women are a minority, because their situation is supposed to be more diverse there, 3) to understand why people choose engineering or not, it is important to study also the reasons for not having chosen engineering.

Beyond case-oriented and variable-oriented approach

When using cross-comparisons in social studies, two main traditions may be identified (Ragin 1987): On one hand, a variable oriented-approach based on quantitative data from many countries, but vague and abstract. That methodology misses the connections to actual empirical process, social bases, specific phenomena, but allows comparison between many different countries, which broadens the scope, but few general conclusions may be drawn out of that king of study. On the other hand, a case-oriented approach, sensitive to complexity and specificity that treats each case as a whole. The drawback of such a method is the difficulty to extend it to a large number of cases because an attention to complexity across large number of cases is very difficult, even regardless of the cultural differences in the case of a cross-national comparison. Another sensitive issue is the possibility to generalize conclusions from a few cases.

From that statement Ragin proposes 'to formalize qualitative comparative methods without departing from the general logic of case-oriented approach' (Ragin 1987, p.x) and recommends 'examination of constellations, configurations and conjunctures' that will describe the causal complexity of the phenomenon. A Boolean approach is recommended to fulfil this programme. This approach is preferred to a multivariate analysis that could not be able to preserve the complexity and the specificity of each case. From Ragin's conclusions we tried to go beyond a quantitative approach and to develop mixed methodologies.

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[2] A detailed view of samplings is given in annex. 200 questionnaires were handed out in each country, 50 female and 50 male engineering students, 50 female and 50 male students who could have become engineers, but chose another speciality. Compared to the national average proportion of women students in engineering, 50% of questionnaires are handed out in settings where the percentage of women students is low, 20% where it is the average, 30% where it is high. Sampling of non-engineering students is composed of 40% of students in Natural Sciences, 20% in Human and Social Sciences, 40% in Economics.

[3] Energy sector was chosen because all countries have at least one company in this sector.

An iterative mixed methodological framework

Mixed methodologies are still emerging, they have been thoroughly described by Cresswell, who reviews the different mixed methodologies and points out the advantages or drawbacks (Cresswell 2003). In our field a mixed methodology offered at the same time the opportunity to use all the available data, both qualitative and quantitative, with heterogeneity due to the different countries. In addition, the concurrent progress of qualitative and qualitative strategies allows iterative approaches, and therefore the emergence of common cross-national research questions.

The WOMENG methodology is iterative and uses three levels of data collection:

- I: An overall statistical framework, built from existing gendered national data, and harmonized at European level. When it was possible, this type of data was collected directly from EUROSTAT, in the other cases, national data was harmonized as far as possible, expressed in international classifications ISCED, ISCO. This data was used as a reference and was a first source of correlation hypotheses. For higher education, this data concerned the identification of key moments in each country when students choose or not choose to become engineers. The idea was to identify when and in which proportion female students were disappearing in the engineering education process. In professional sphere, this data consists in number of men and women engineers in different positions and ages, average salary, sectors, unemployment, qualification, access to continuous education, etc.
- II: Specific quantitative data collected by the project on specific questions. The aim was to check hypotheses in a comparative context and to identify factors that increase or decrease the probability to choose engineering. This data was provided by WOMENG designed questionnaires to specific samples in higher education, and by the collection of information on chosen companies for professional sphere. This second set of data was of particular importance in higher education.
- III: Qualitative data from interviews, focus groups, participant observation and document analysis. The aim was to understand why and how specific situations may be explained from the inside, and to find reasons and explanations for results observed in the data I and II. Common issues were addressed in the different sets of data, for example “why did you choose engineering”, “what is your image of engineering” in higher education, or “balance between professional and personal life”, “glass-ceiling”, “gender corporate policy” in professional sphere.

Quantitative and qualitative methodologies were designed to allow mixed methodologies as some questions are common to questionnaires and interviews or focus groups. So we had the possibility either to identify relevant results in questionnaires and to check qualitative results for an in depth interpretation of those results, or to compare qualitative results to average results in questionnaires and to assess the representativity of case studies investigated through qualitative methodology. For example, it was possible to know if the opinions of interviewed students represented a common usual view on the subject or a very specific and individual analysis of the situation.

Some guidelines were experienced for combining qualitative and quantitative results. Here are two examples:

- Cross-reference tables for qualitative and quantitative methodology: for a given item in questionnaires, the corresponding questions in qualitative methodology are given.
- Qualitative data is presented to highlight most obvious results: answers 1 and 2 (completely disagree/disagree) are added and opposed to the addition of answers 4 and 5 (agree/totally agree) in percentage. Results are then compared country by country to the average result. When a national result is very different, further analysis is proposed, using qualitative results.

Again, there are lots of possible analyses, only the most obvious ones have been experienced at that time. Comprehensive and methodical analysis will take time.

The large-scale issue

As there are different sets of data in seven different countries, and for each set of data, numerous results, browsing the database becomes a challenge. To give an idea, there was two hundred questionnaires in each country, each questionnaire had an average of one hundred questions and six hundred items, took one hour to fill and was designed for four samples: female engineering students, male engineering students, female students who did not choose engineering but could have chosen, male students who did not choose engineering but could have chosen. Interviews and focus groups address an average of six or seven main issues with sub questions; there are an average of twenty different interviews or focus groups in each country for education and professional sphere (which makes a total of forty). As only the English summary of an interview represents two to three pages, each country produced c.a. one hundred pages of qualitative data, so the cross cultural analysis requires to master seven hundred to one thousand pages of qualitative data, that must be added to the enormous amount of quantitative data.

This situation implies that the direct access to the data, which is the usual research situation, becomes no longer achievable. The data is always filtered by translation problems, by reports and summaries made by national researchers, and by our sometimes poor or unequal knowledge of national situations. Though, this filter effect must be kept under control through various procedures to report on national results the same way and to provide information for analysis assuming that each researcher trust each other to report on their national results in a common way.

A second filter is the ways of browsing the database. In a small amount of data, transversal reading remains always possible. When the amount of data is increasing, it becomes time consuming for sometimes-ineffective results. The need for browsing technical tools has been underestimated, they must be developed at least to test quickly some hypotheses before an in depth analysis. Our process in reporting and classifying results insisted on the linear process of the interview, which is interesting to catch the inner logic of each interview, but is not very convenient for addressing the same question in different settings. A better design of the database would consider each question as a field and integrate database design in the research design itself. In addition, a partner with a good competence in software design would be very valuable in a next project.

Specific practical problems during research progress

Because of the extension of the project, we encountered practical problems during the research progress. Even if they have nothing to do with epistemological problems raised by cross-comparisons, it may be very useful to mention the most important ones, because they can be underestimated and cause postponement and difficult management of the consortium.

Timing

In WOMENG, the main point we had underestimated was the timing for handing out the questionnaire or doing interviews, which can be different from a country to another. It is rather easy to ask a professor to give one hour of lecture for handing out the WOMENG questionnaire if it's the beginning of the semester, it becomes more and more difficult when the end of the semester is approaching, and it is

impossible when the exams are coming or when students are on holydays or training periods. The same problems exist with companies; they are not available at all periods of the year. Another problem is to find equivalent settings for handing out questionnaires or interviews, especially in higher education where the organisation of the academic work may be very different from one place to another. For example, in Finland, it was difficult to find lectures; in Austria it was difficult to find enough female students in electrical engineering, etc.

Due to the extension of the research, each partner had to rely on its personal network to find appropriate persons and contacts in universities and companies, according to a define sample. Academic support was uneven, especially when partners were not academic teams.

Addition leads to expansion

Instruments tended to be too long, some students or colleagues were afraid of filling or answering them because it takes at least one hour. This is maybe the price to pay for a collegial design of common instruments for all workpackages, where all partners were free to propose questions they consider essential to them. This solution limited the number of different instruments, which was very efficient, but lengthened each instrument. The design process could be improved in order to be less cumulative and more integrated, but due to the number of partners the balance is not easy. For the same reasons, some questions were not adapted to the national context, it did not prevent the overall quality of the answers, and students were aware of that fact, but answers are not reliable for those questions, and some students complained about them. The inappropriate questions were mostly on women welcome day, girls' recruitment programme, and specific gender policies, which do not exist in some countries.

Translation issues

Technical process for collecting and reporting must be addressed very carefully to avoid missing data or confusing data, and consider the huge amount of data. In WOMENG, research was designed in English, then guidelines were translated in national languages, fieldwork was handed out in national languages, afterwards results were summarized and translated back to English. Even if partners were very careful, there were some translation problems. For instance in Questionnaire 1 are the answer categories at question 32 "negative vs. positive influence" and in German, it becomes "not important" to "very important", that means that results get a different meaning that must be interpreted carefully. Another translation problem is about slightly different meanings or connotations of words, that is an overall intercultural methodological challenge to interpret carefully.

Access to collected data

Another effect of the extension of the research is the fact that during a long time, we had no immediate access to the results. Statistical treatment of the data was long and not so easy due to the large number of questions. After basic processing the data, all the items have been tested from the country and gender point of view according to character of the variables: Kendall's tau-b, Somers' D, Spearman's rho, Mann - Whitney test, Analysis of Variance, etc. Although, it is essential to combine those quantitative results with qualitative results in order to work on an interpretation.

The toolbox

Anyway, through research experience, a methodological toolbox emerged from the WOMENG project. We try to summarize our methodological findings in the next paragraphs. Four steps may be identified: designing, doing fieldwork, reporting, analysing and interpreting.

It seems crucial to keep in mind that those steps are connected, and that only collegial process can ensure comparability. A mono-national approach would reveal itself completely inappropriate when doing fieldwork or interpreting in other countries, so other partners would adapt it to their specific situations with many distortions, or they would apply it even if this approach is inappropriate and doesn't catch the main characteristics of their specific situation. So the final outcome would be inappropriate for cross-comparisons, as comparing tangerines and carrots, or useless because only one paradigm would be explored, erasing other cultural settings without bringing the benefits of cross-comparisons. On the reverse, working as a multinational team at each step is the key element to ensure comparability and to preserve national specificities as when comparing grapefruits and tangerines. Through that common work are emerging similar categories, similar configurations that allow new hypotheses, but don't deny the diversity of each specific setting. "*In varietate concordia*" as expresses the European Union.

Designing research project

After discussion among partners, WOMENG project was structured in two parts, education and profession of engineering and three "workpackages": reasons for choice (WP2), satisfaction and dissatisfactions (WP3), organisational cultures (WP4). WP1 "methodology" was responsible for designing common research tools and ensuring comparability. The hypotheses were taken from state of art of European and non European research. The operational definitions of research issues were done in connection with state of art using different quantitative and qualitative methodological measures.

Each WP proposed specific groups of questions in relation with its hypotheses; those questions were gathered and reviewed to ensure coordination, relevance and exactness in all national contexts. Several versions were produced and improved till a final version of methodological guidelines.

Then this final version of guidelines was translated into national languages. Major translation problems were avoided thanks to the collaborative design, but some irrelevant questions in certain contexts remain. A more rigorous methodology could be implemented, especially for questionnaires, using methodologies developed at ZUMA, Manheim for example (Harkness 2002).

On the field

Due to the number of different actors and contexts, fieldwork procedures must be described very clearly and take into account cultural differences, cultural bias, socially desirable answers, etc. Any non-documented difference could introduce additional distortion to the survey. If it seems impossible to ensure perfect equivalence in the different settings and to refuse any adaptation, it is important to identify common research situations and to avoid obviously different methodologies or procedures. Another crucial element is an accurate documentation of the research context through biographical data, identification of relevant samples, etc.

Reporting

The idea was to work as close as possible to the original data, even if it was necessary filtered by the translation into English, the summaries and the national reports. Complete transcription and translation of qualitative results would have been too heavy in terms of time, money, and human capacity to analyse tons of data. On the other way, relying on national reports without any access to original fieldwork would have reduced the benefits of cross-comparisons with the risk of juxtaposing together national studies without comparing them. So an intermediate methodology was experienced: each interview or focus group was summarized in English, question by question, with an average of ten lines for each main question. Reporters were asked to quote important sentences, to identify general patterns and to stress national specificities. On the side, a column was added to add comments and first interpretation. This methodology was efficient to allow an easy access to national material in context, even if outcomes were in a way filtered by the national partners. To help interpretation, short national reports were added to propose a first interpretation at national level and to explain the specific contexts. All this data will be soon available to all researchers on WOMENG website.

Analysing and interpreting

Through this methodology, relevant and comparable material has been produced, with appropriate documentation. Anyway, analysing and interpreting represent a challenge due to the tons of data we have: 1)The overall statistical framework; 2)The WOMENG quantitative data: questionnaires in higher education, information on companies in professional sphere; 3)The WOMENG qualitative data: summaries of interviews and focus groups, document analyses and all biographical and contextual information; 4)The national reports. An iterative mixed methodology may combine all the data in original ways.

At the moment, only few possibilities have been explored. Main difficulties must be mentioned:

- Technical difficulties to browse the results and lack of immediate, intuitive perspective on results due to the amount of results. Designing appropriate software could solve this.
- Epistemological difficulties in choosing meaningful comparisons and conceiving qualitative data comparison. As obvious in the next example, there are many ways of comparing: men to women, engineers to non-engineers, one country to the average, one country to another one, what is specific to the average, what is common to all, etc. Among all those possibilities, which one is the most interesting?
- Another challenge is the methodology for qualitative data comparison. There are few works on the subject, and again, the amount of data and the fact it has been summarized and translated represent a limitation. A more or less intuitive identification of recurrent ideas has been experienced, but it could be possible to try coding or mapping of the main concepts and their links as Ragin did (Ragin 1987).
- A last open question is the way of mixing qualitative and quantitative data in the analyses. As Cresswell has shown, there many ways of conceiving mixed methodologies (Cresswell 2003).

Conclusion and Open Questions

From a methodological point of view WOMENG results illustrate how an iterative cross-cultural mixed methodology allows a fruitful comparisons that goes far beyond the usual statistical comparisons, with the limits it implies: never forget you compare grapefruits with tangerines. Anyway, further research in

methodology for cross-national comparisons remains necessary: If the methodology for research design, fieldwork and reporting may be considered as rather well documented, which ensures comparability and commensurability, the methodology for browsing the data still lacks efficient technical tools, and the methodology for qualitative comparative analysis needs further research. Further research on those topics would open new perspectives for large scale cross comparative social research.

Beyond technical considerations, an important result of WOMENG is the necessity of collaborative work al all levels, from research design to interpretation and analysis, to ensure comparability and meaningful cross-cultural comparisons in context. Even if sometimes defective and unsatisfactory, the research methodology allowed on one hand the most possible direct access to rough commensurable data, and on the other hand, the access to cultural and historical background essential to analyse and interpret.

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Gendered Organisational Cultures in Engineering. Theoretical Reflections on WomEng Results and Future Research Perspectives

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Abstract

The purpose of the paper is to give on basis of the summary of results, especially from work package (wp) 4, theoretical reflections which are apt to connect results to state of the art on one hand and theory on the other hand. Two main streams of thinking will be first to look at gender characteristics of women, who observe or live in engineering, and second to look at construction processes of gender and engineering. Both perspectives with their diverse theoretical concepts, for example socialisation, gender segregation, marginalisation, masculine hegemony and masculinities, interdependence of gender and engineering will be presented and taken for interpretation of WomEng results. Several open questions will be put for further research. Interpretation of coping strategies of female students and professionals in engineering education and occupation, even though some interpretations are possible, needs further research focussing on these possibilities. Entrance to and structure/functioning of male networks for career in engineering need urgent investigation, because this factor is central in hindering women going forward. More societal conditions like integrating family/private life and working life should be an overall issue of research and social change.

1 Introduction

The aim of this paper is to reflect results of WomEng, especially those of work package 4. So the focus is lies on organisational structure and culture of institutions/organisations of higher education and industrial companies relevant for engineering education and profession. As these organisations are not gender neutral, the reflections will include the genderedness of organisation (Acker 1990). The idea is to offer possibilities for theoretical interpretation for the investigated and analysed particular people and organisations[1], and to compare the structural and cultural elements with theory and research. Based on summaries of results from educational and professional sphere four research and theoretical fields which can be taken for interpretation will be sketched: gender, organisational, masculinity and feminist technology studies.

[1] For methods and sampling see Genin/Pinault (2005) and Sagebiel (2005 a).

2 Summaries on Gendered Organisational Cultures in Study and Profession

Summaries will present short cut and focused results from educational and professional project phase of WomEng. Educational aspects will be engineering in a male domain and minority status, masculinities and coping strategies, masculine image of engineering and femininity image and interdisciplinary and single sex education for fighting gender and engineering stereotypes. Professional aspects will be masculine culture and minority situation of women, job priorities and career, different working styles, men's and women's networks and opinion about special measures for women.

2.1 Results on organisational cultures in engineering education in Europe

Engineering education in a male domain and minority status

Being male domains, engineering studies are less attractive most of all because young females fear of being lonely between many young men. Female students, asked in Germany, France, Austria and Slovakia, are conscious about their study in a male domain and see their study contents as male dominated.

Female students, who complain about feeling of loneliness, study in UK, Austria and Slovakia and tell also about experiences of negative attitudes against them. These students characterize the atmosphere as *'no mistakes are allowed'* and see a big distance between faculty staff and students, while the opposite seems to be true for France and Germany. Females there feel acceptance over all (and even appreciate their exotic status) and tell, that, because of the open atmosphere with their male colleagues they do not feel any isolation, and don't long for more female students nor women teachers.

Masculinities and coping strategies

French females sometimes take an advantage out of their minority situation and have developed a special coping strategy: "It's easy to ask questions when we don't know, we pretend we're a little bit stupid and I sometimes say: sorry, I'm a girl, so I can't understand everything, so everybody laughs and I play with it". But, it would be a misunderstanding thinking that discrimination has gone: female students "are marked off very subtle; discrimination turned to be more subtle nowadays", the equal opportunity officer from a German university of applied sciences says. Special male oriented language and humour is spoken in all countries. Stupid jokes are common (Germany, France, Austria) and women behave the same. As this is a crucial element of masculine culture in engineering degree courses and departments, the question is how the women's adaptation to this behaviour can be interpreted (Sagebiel 2005b, Sagebiel/Dahmen 2005a, Sagebiel/Dahmen 2005b). Predominately competitive and masculine climate in engineering degree courses is one deterring factor. For coping with this competitive male behaviour "some women adopt the competitive imperative, and learn how to compete in male terms. Men are often not comfortable with this. It is their game, and there is no place in their prestige system for a woman who competes successfully with them".

Masculine image of engineering and femininity image

The image of engineering in the society is still a masculine one in the view of female students (Germany, France, Austria and Slovakia): machine oriented, with less communication, rational but not creative, not positive, but combined with earning a lot of money. Departments of engineering degree courses reflect

this masculine image, especially in the view of the female faculty. Female students see a conflict between engineering and femininity image, and most of all in the eyes of other women. Female students explain their low number with different socialisation: *"It is still a question of education which is different for girls and boys"*, and refer to the influence of peer groups: *"Women are pressed into typical female subjects or may be they choose those typical female subjects themselves. And peer groups are very important, too"*.

Interdisciplinary and single sex education for fighting against gender and engineering stereotypes

The results (Sagebiel/Dahmen 2005a,b) show, that, even though there are diverse engineering educational organisational cultures in the partner countries, enduring gender and engineering stereotypes with sets of dualism still exist in the society and engineering education. These influence our thinking fundamentally and make for the gap between the number of women and men studying engineering and working as an engineer. In education two central elements for fighting against gender and engineering stereotypes and weakening gender segregation are interdisciplinary and single sex education. Out of non-technical subjects languages are mostly liked with over 50,0% agreement in all countries, followed by soft skills. But, looking for possible changes, most of the faculty think those interdisciplinary subjects can not be included, because otherwise indispensable technical subjects would have been cut.

Self-confidence is seen by most of the faculty as a prominent factor for females being successful in engineering studies, but whereas members of the investigated single sex degree course in Stralsund/Germany stated the opinion 'single sex teaching increases self-esteem and self-confidence' of female students, most of students and faculty are opponents of mono-education, thinking 'that is an artificial world' and that women who want to study engineering must have self-confidence right from the beginning. Interdisciplinary and single sex education can be interpreted as approaches to increase the number of female engineering students.

As known from other research, female students mostly criticise lectures as boring and without enough practical links.

2.2 Results on organisational cultures in engineering profession in Europe

Masculine culture and minority situation of women

Women engineers are aware of their minority situation in a male domain; men build it up since generations concerning their needs, long enough without the presence of women. The organisation of work and the way of working is attuned to the male model.

For some of the women it was a big challenge to work in a male domain at all; they agreed that women constantly have to prove that they are competent, working hard, know what they are doing and want to be taken seriously. They also agree that it is not easy to assert oneself and gain acceptance if you are a woman. *"It is a men's world and women have to accept that it is a men's world,"* as an Austrian female engineer said.

The women at a Slovak company talked openly about facing completely different problems in comparison to their male colleagues, the explanation for the discussion members lies in traditionally different position in family and society. Also the general approach to the problems or failures caused by women or men is different: if a woman 'spoils something' the reaction is usually as follows: *"well, she is just a woman, what else*

could we expect from her (woman has a 'hen brain')?" If there is a problem caused by a man the reaction is: *"well, it could happen to anybody."*

All over Europe the women told about masculinity and at the same time about not having problems with it. Two explanations are possible: the awareness of masculinity is confirmed, but masculinity is really not a problem, or women engineers must not have problems caused by their tough image. The asked Austrian women clearly stated that they still feel as being a minority and being dominated by masculinity and they also told about the culture of sexist jokes.

In contrary to high job satisfaction engineers who quit also told about the masculinity and the minority situation of women being one main reason for dropping out especially in France and Germany. *"I had to fight to convince the company that as a woman I could make it!"* (French women engineer who quit).

Job priorities and career

The work content, atmosphere and work-life-balance are especially valued by all asked women engineers, if in conflict partly by evaluating career less. Women engineers with children take the possibility of part-time working and avoid overtimes.

The interviewed women managers all over Europe combine family and career and live in a work-life-balance, but they are unknown role models as women engineers who are not working at this career level normally do not have contact to women managers. Especially younger women engineers still fear a career break when having children and looking for a work-life-balance, according to the asked engineers in Germany and Greece. Women in Germany, Austria, Slovakia, France and Finland do not drop out from job when having children.

The other side is that, even if some women do not have and do not want to have children, they nevertheless meet and feel the prejudices of all women having children, combined with less career support in comparison to men.

But reality shows that part-time working does not have the same standing all over Europe. In some countries like Germany, Austria, France and Finland part-time working is quite normal and accepted and offered at all companies especially for women having children, but in other countries, like in the UK and in Slovakia, it is offered rarely.

With working part-time a dilemma develops for women: the absence of the possibility of part-time working can lead women to drop out, while taking the advantage of a part-time job leads to a situation, that a women engineer sometimes is considered as an assistant.

Hindering factors for making career in the view of women engineers are often the sacrifices they fear to be obligatory, like heavy workload, flexibility in times spent at workplace or different workplaces. *"Career efforts to pay a certain price,"* was a main statement in both German discussion groups. *"A career you can only have if you completely sacrifice yourself. Those who are prepared to have no private life, no hobbies, nothing but the company from dawn till dusk…"* an asked Austrian engineer said. In Greece some interviewed women and men expressed the fact that the typical masculine atmosphere in this field deters women from making career in engineering.

Different working styles

The opinions of women managers about gender differences in profession, especially in leadership style vary from country to country. While asked engineers in France and UK explain differences in leadership behaviour with personality traits, many of those asked in Germany, Austria, Greece, Finland and Slovakia tell about different styles by gender. When asked about what is important for management, most of the asked managers see team work, working atmosphere and fewer overtimes as central, in contrast to male colleagues in same position. Overtimes versus part-time are central elements of masculine versus feminine organisational cultures.

Concerning the working hours and doing overtimes there is a big cultural difference in Europe. In Germany, France, Slovakia, and Austria and in the UK it is quite normal to do overtimes and show all time availability. The feared pressure of doing overtimes when having a management position is very high in Germany, preventing many women from career aspire.

One of the coping strategies working in a male environment is to show great self-confidence. All women admitted that men show much more self assurance as one Austrian woman engineer pointed out: *"Men have a gigantic self-assurance. Even if they know nothing they open their mouths. Women open their mouths only if they really know something. That is where we do not match at all"* and a woman engineer from Finland said: *"I'm working like a man!"* and some French women adopt that behaviour too. Asked Austrian women engineers think there is no need to change into a man either. *"You should remain a woman. That is okay. But if you are oversensitive, than that is of course a problem."*

Men's and women's networks and their functions of furthering and hindering careers

Most of the asked women engineers in Germany, Austria, Greece and France see the priority of work-life-balance and restricted chances to entry in men's networks as well as defined gender differences in profession as barriers for making a career as women engineer.

All women engineers are aware of the male networks. Women, even though having restricted access to the men's networks, see these networks as the most prominent factor for career. Men's networking

starts with informal meetings while drinking a coffee or smoking a cigarette, continuing to so called informal meetings after work or for example 'sauna meetings' in Finland, where men can communicate also about the professions.

At a German company, strongly practicing a diversity concept, the women managers think that the diversity programs and the lived diversity decrease the might of the old boy's network. Diversity having a great weight as a kind of corporate identity supports women by being a contradictory part to the old networks. Women networks at the moment seem to be not strong enough to further careers of women engineers. In Germany an interviewed woman manager said "*You need someone to push and you need someone to pull*".

Opinions about special measures for women engineers

Many of the asked women engineers are sceptical to special measures for women. Advertisement for women engineers only exists in Finland. Gender mainstreaming programs are accepted differently by asked German, French and Greek women. They don't exist in investigated companies in the UK, Austria and Finland.

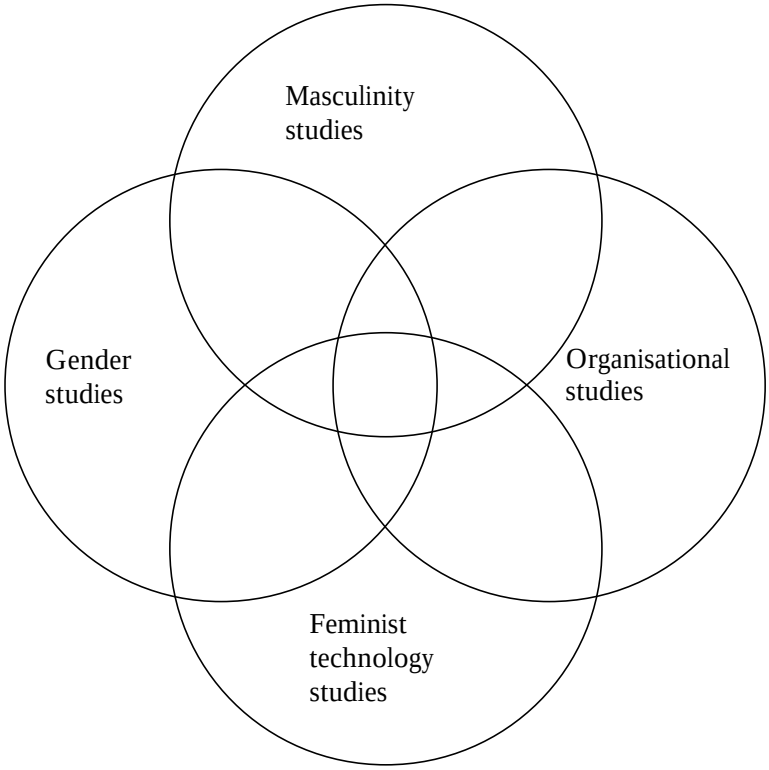
Most of the women engineers all over Europe agreed on needing more visible female role models – in contrast to most of the asked female students. The Austrian perception is that more women would bring

about different experiences for the men and consequently a change in their behaviour and of the working atmosphere. But an asked French women manager has a different approach towards this topic, *"I don't think that people really distinguish between men and women…"*

3 Theoretical reflections of results

There are four theoretical fields at the moment which can be useful for interpretation of WomEng results, each of which has its own focus on results but at the same time all fields are interconnected: Gender studies, organisational studies, masculinity studies and studies on feminist technology, which is demonstrated in the following picture (see picture 1).

Figure 1: Theoretical fields relevant for interpretation of WomEng results



3.1 Gender studies

Gender studies offer an overall perspective on the issue of gender and engineering, from normative as well as constructive view. Examples of normative thinking are socialisation concepts and gendered hierarchical division of labour, examples for constructional thinking are concepts of construction of gender and 'doing gender' in combination with construction of engineering and engineering culture. To explain WomEng results you have to look at the two poles of gender in engineering. One is the taboo of gender differences, for instance rejecting special measures for women and adapting to masculine behaviour. The other can be seen in strengthening of gender differences, in view of gendered management styles, of work-life-balance as women issue etc. in accepting a gendered division of labour in society.

Theoretical reflections of the project have to combine a perspective of gender differences, differences between women, and at the same time of construction of gender differences in a two-gender-constructed society (Hagemann/White 1994). Main feminist perspectives on engineering focus on female socialisation process, and thereby ***gender differences*** on one hand and dichotomous stereotypes in ***constructing***

differences of gender on the other hand. The ***construction of masculinity and of engineering as masculine terrain*** can be seen in parallel way. Even though reality has changed both in gender and engineering the stereotypes are still alive and they are still influential as most women do not choose engineering as degree courses so long as it seems to be unchanged a men's field.

Female Socialisation process

Feminist explanation for the small number of women in engineering was first the ***female socialisation process*** (see e.g. Bilden 1991), which holds girls back from playing with tins and machines in the early childhood. Moreover, as the psychoanalyst Chodorow has analysed, girls tend to separate from their mothers not as early as boys and so develop their identity in close relationship to those of their mothers. Based on gender differences and ***female socialisation theory*** in the nineties several initiatives started to compensate girls assumed deficits in the technical field. Research focused on evaluation of these measures (Sagebiel 2005 c, chapter 2).

But less technical competence is no reason seen in research, so the definition and construction of gender differences seem to be more promising, as in puberty girls are anxious in the adaptation to the female image and to be not excluded from their reference group. One characteristic in this period is not to pretend to like natural sciences, maths and technology as these fields seem to be male terrains. So girls learn to adopt what they think is the prevalent female image and to avoid deviant behaviours from these images.

Social construction of gender and gender segregation in engineering

In the beginning of the nineties feminist theoretical thinking shifted to the ***construction of gendered world and/or gendered segregation in social order***. Theory of social construction explains gender as a result of gendered definition processes. Gender is differently structured throughout the world, and it is structured through daily interaction. This means that everywhere social constructions of separate worlds for women and men developed and are reinforced in everyday life. ***Social structure of exclusion*** is one characteristic of ***gender segregation*** which has always reinforced social order. Even though exclusion can be interpreted on a macro societal level, feelings of being excluded are a source for deeper insecurity feelings with a negative influence on self-confidence. Self-confidence is the most prominent single factor for success especially in male dominated fields, in study and professional life. People construct their social realities and identities, shaped by rules of social life, cultural expectations, workplace norms and laws. By constructing themselves and responding to the definition by relevant others, women and men build up their identities (interaction theory).

'Doing gender' or 'undoing gender' – single sex education and interdisciplinary of engineering

Two central elements for fighting against gender and engineering stereotypes are interdisciplinary and mono-education. Both can be interpreted as approaches to weaken gender prejudices and gender segregation.

As a quasi 'paradox intervention' (Kahlert/Mischau 2000, Jordanov 2002, Gransee 2003, Teubner 1997, Wetterer 1996) single sex education of female students hypothetically can deconstruct gender differences. Instead of those differences, differences between female students are allowed to become visible. The

positive significance of single sex educational environments on female students' self-confidence could be high (Metz-Goeckel 1996).

Research of the prominent German institution ZUMA (Glöckner-Rist/Mischau 2000) has shown a broad acceptance of single sex educative women's university under certain conditions in different groups. But INDECS[2] as well as WomEng results have shown still existing negative attitudes and prejudices of male teaching staff and female students especially.

As in all European countries women are prevalent in language and cultural studies, and men prevalent in natural and even more in engineering studies (ETAN 2000, Blättel-Mink 2000) integration of non-technical contents could meet interests of female students who would not study engineering without interdisciplinary.

3.2 Organisational Studies

Organisational studies offer a more concrete view on structures, in which engineering is functioning in study and profession as well as elements of formal and informal organisational culture. With the perspective of gendered organisations – the term stems from Acker 1990 (after Wilz 2004: 446) – there exists a close relationship to gender studies, which means that organisational characteristics are not gender neutral and have different meanings for women and men in engineering organisations.

In WomEng project, while traditional engineering degree courses out of many reasons are constructed as a male and masculine world, efforts for change must start at deconstructing masculine organisational culture. Women's 'invisibility' within engineering, not only because of their absence as staff and students but also in terms of any recognition of their contribution to the history of technology must be changed for providing a suitable study environment at higher educational institutions.

Most of the concepts of organisational studies are close to the main issues and results of professional sphere of WomEng analysis as career, leadership, communication and decision structure, corporate identity, networking. The concept of gendered organisation does not only fit for description and explanation of empirical finding, but can enlighten background societal interdependencies. For example because the concept of "normal employee", being male biased, is implicit in recruitment policies of companies, the decisions cannot be gender neutral. Or another example, because of separated worlds of productive and reproductive work in society company policies for work-life-balance will be female biased. Studies on gender segregation (e.g. Allmendinger/Podsiadlowski 2001) have shown, that one organisational perspective seeing the lower status of women in companies and other professional organisations as combined with their minority status and being hindered to entry men's networks (Kanter 1977, after Wilz 2004: 445), promising change by a higher number of women in the field, have not proven to be true. Even the high number of women in a professional field does not lead to a greater number of them in higher positions. Moreover several studies have shown that women are overrepresented in routine and "dead end" jobs (Wilz 2004).

[2] For final report see www.INDECS.uni-wuppertal.de. For more information about European project INDECS Beraud 2003, Sagebiel/Hoeborn 2004, Sagebiel 2005c.

3.3 Masculinity studies

Even though masculinity studies could be seen as belonging to gender studies, they have developed and defined own concepts like hegemonic or dominant masculinity, which seem to be of special value for analysing engineering organisations. Together with the organisational concept of networking this view helps a lot in understanding the history, structural characteristics and functioning of male networks, being a main barrier for women's careers and change of society by the time. The difficulties to change a long time vested male image of engineering can be explained partly by the strong interests in close relationships between engineering and masculinity from historical connection between a masculine military organisation and the development of engineering inventions (Greif 1996).

In research literature the masculine atmosphere is blamed for hindering women from retaining and finishing their engineering study or feeling not "at home", leaving after the exams making no efforts for a planned career in the field (Sagebiel 2003). So it is not the "hard" subject of science which explains withdrawal of female students – they normally succeed in these subjects likewise as male students, but the felt women excluding atmosphere.

The feminist perspective of women's and gender studies goes along with critical men's studies' perspective (Sagebiel 2003, Höyng/Puchert 1998, Connell 1999). Höyng and Puchert found in their qualitative study of organisational and working culture in a city administration the dominant masculinity still in power positions, with working principles – for example overtimes and "Stammtisch" culture – which are apt to exclude women. Bob Connell sees the so called 'hegemonic masculinity' as central. Elements of this dominant masculinity (Connell 1999) are male fraternities by stories, jokes, leisure sports and similar informal strategies, all constructed explicitly or implicitly for exclusion of women – conscious or/and unconscious (Sagebiel 2003, McLean et al. 1996, Faulkner 2000).

3.4 Feminist technology studies

Feminist technology studies offer with the combined view of gender and technology studies a basis for a deeper understanding of the reproduction of gender segregation in engineering with the side effects of minority situation, adapting to this situation and possible marginalisation for women living, studying and working in the male dominated engineering field. Most prominent is the binary thinking about technique and gender and the combination of both with the polarisation between male and female and the devaluation of the female side.

Feminist research on technology suggests that ***female identity construction*** conflicts with existing identity and construction of engineering. Women therefore will not choose engineering or will leave before finishing. On the other hand masculine image of engineering will change when there will be a greater amount of non-technical contents in the former single degree course.

Women's marginalizing process in technology

Enduring gender and engineering stereotypes with sets of dualism influence our thinking fundamentally, like: People versus technology, soft versus hard technology, concrete versus abstract approaches, body versus mind. Those dchotomies can be seen as central to Western culture and economy. With this background Wajcman (1996) sees ***women's marginalizing in technology*** constructed in the following ways:

Girls' toys are often associated more with caring and social interaction while on the other side computer games often frustrate the non-macho players exposed to them. Wajcman sees several factors working in the same direction: the boys' have overall more time for using computers, a peer group street culture playing with computers, which is mainly male. "Thus the new technology was slotted into a pre-existing male subculture and took on its masculine face." (Wajcman 1996:155) "In modern societies it is the *education system*, in conjunction with other social institutions, which helps to perpetuate gender inequalities from generation to generation." (Wajcman 1996:151) Part of the so called 'hidden curriculum in constructing gender differences in school is a belief that 'mathematical mind' is perceived as non-feminine and that maths is connected with computing. So, interested girls have to fight for computers against boys' computer time and this experience continues into tertiary education. The problem is from this experience in school "girls internalise the belief that boys possess something they lack; difference is lived as inferiority" (152). The stereotypes of ***male competence and female distance to technology*** are created. Next step is that "the absence of technical confidence or competence does indeed become part of feminine gender identity, as well as being a sexual stereotype" (Wajcman 1996:155). The construction of gender differences continues as "Males are portrayed as fascinated with the machine itself, 'being' hard masters'….Females are described as only interested in computers as tools…"(Wajcman 1996:156). This is similar to Erbs main outcome ***that women's distance to technique comes from their narrow definition of technique*** (Erb 1996).

After Judith Wajcman (1996) masculinity in technology means at **first** that "the very definition of technology…has a male bias" (137) "We tend to think about technology in terms of industrial machinery and cars, for example, ignoring other technologies that affect most aspects of everyday life"(137). This "is not inherent in biological sex difference. It is rather the result of the historical and cultural construction of gender… the ideology of masculinity has this intimate bond with technology" (137).

Social construction of masculinity and engineering

Bob Connell (1985, 1987, after Wajcman 1996: 143) sees the so called 'hegemonic masculinity' as central. It is achieved by the organisation of private life and cultural processes. "In contemporary Western society, hegemonic masculinity is strongly associated with aggressiveness and the capacity for violence"… "The cult of masculinity is based on physical toughness and mechanical skills is particularly strong in the shop-floor culture of working-class men" (Wajcman 1996: 143).

The bond between hegemonic masculinity and engineering lies in the social construction of engineering as masculine issue in the polarisation female-male. In the advanced industrial world, where scientific and technical rationality are highly valued, these associations that women are more emotional, less analytical and weaker than men, play a powerful role in the ideological construction of women as inferior" (Wajcman 1996: 145).

The special unsuitability of women for technology is demonstrated by the example of military… "Many feminists also see war and soldiering as male and believe that women are naturally inclined to pacifism" (148). "Their role as mothers is supposed to lead women to value growth and preservation, against death and destruction" (Wajcman 1996: 148). Even though this argumentation fits in social desirability and political correctness, it is implicitly reinforcing a traditional model of masculinity and femininity.

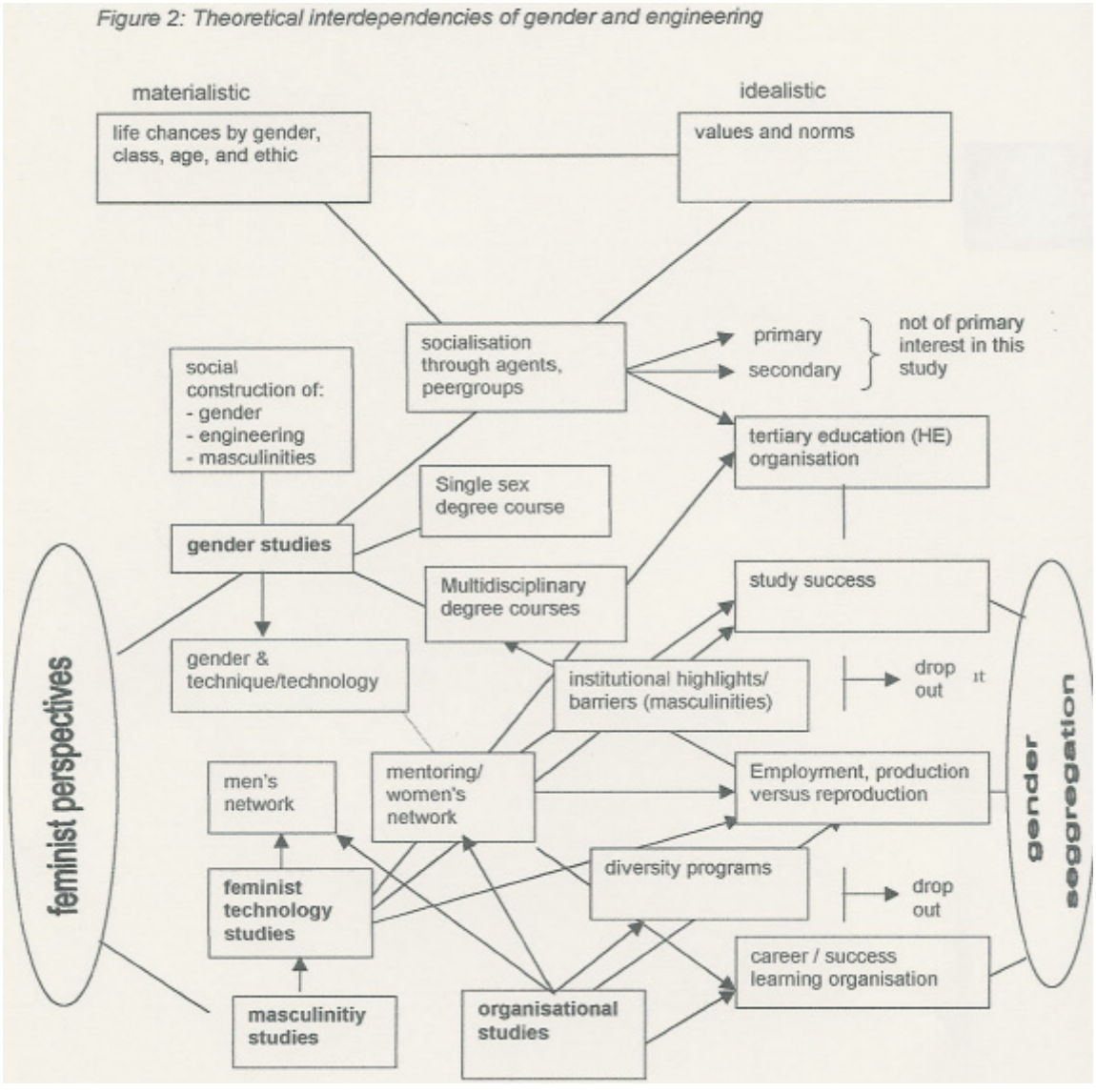
Carol Gilligan's view that women's cognitive and moral development is distinctly different from that of men is criticised by Senegal and Lloyd (after Wajcman 1996: 149) because of the support of patriarchal

ideology and at the same time is not true, because armed forces importantly depend upon women, both directly and indirectly. And as development of new 'soft' technologies has shown men in order to maintain this male dominance over new and unfamiliar kinds of machinery, this willingly adapt and modify their ideas about masculinity.

Popular images of science and technology have strong connotations with the masculine sides of dualisms, such as hard – soft, abstract – concrete, people-centred – technology-centred, mind – body, rationality – emotionality. 'Sexual ideologies and stereotypes are diverse and fluid, but such opposites as "male/female" and "reason/emotion" are central to Western culture (Sagebiel 2003, Wajcman 1996: 145), they are extremely persistent and change only very slowly.

Even though exclusion of women by gender segregation can be interpreted on a macro-structural societal level, feelings of being excluded could be a source for deeper insecurity feelings with a negative influence on self-confidence. The feeling of technical incompetence coming from puberty or/and a narrow definition of technique reduces self-confidence of women (Sagebiel 2003, Wajcman 1996, Erb 1996).

Figure 2: Theoretical interdependencies of gender and engineering



The above picture shows an overview of theoretical and research fields as well as dimensions which have been the focus of the WomEng project. Most prominent is the feminist and gender segregation perspective on the left and right side. The terms with fat letters show the theoretical fields, which scientific knowledge value was sketched above.

4 Conclusion for future research

In conclusion, because historically grown and rooting in societal traditions, it will take a long time to overcome still existing masculine organisational cultures. Moreover arguing about gender differences one is in danger of reification enduring processes of doing gender, whereas working with the concept of deconstruction of gender and avoiding looking at possible gender differences will not skip still existing masculinities and discriminating practices in the field, nor can possible special potentials of women in engineering become visible.

At the moment it is obvious that even though some theoretical integrative work has been done, much more theoretical-analytic research has to be done to integrate WomEng results in relevant state of the art in more detail. Nevertheless some explicit empirical-analytical questions should be investigated in future research like the explanation of adapting coping strategies of female students and professionals in engineering, the entrance to and structure/functioning of men's networks for career in engineering and the gendered implications of work-life-balance as organisational strategy.

The students Jenia Buksman, Shirin Reinhard und Monika Schmidtke helped with revision of the paper.

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